



Universiteit Utrecht

Environmental impact of banning plastic carrier bags in the city of Utrecht

Master's thesis; Sustainable development



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Summary

Plastic carrier bags have a large environmental impact. Not only the production of plastic bags is unsustainable due to the raw material use and their low recycling rate, plastic bags also have shown to be a large source of pollution, both on land as in the oceans. This study examined the effect of implementing three scenario situations in which a ban on plastic carrier bags was implemented in the city of Utrecht. The study was carried out by conducting a survey among consumers in the city of Utrecht. In this survey, respondents were asked about their current carrier bag use and how their behaviour would change in the different scenarios. Not only consumers behaviour was examined, also a screening LCA was performed in which the environmental impact of the purchase of carrier bags in the current situation was compared with the three scenarios.

Results showed that the decrease in purchase of carrier bags does not outweigh the increase in environmental impact due to the shift from plastic carrier bags to carrier bags considered for multiple use. A scenario in which not only plastic carrier bags are banned, but single use paper bags are banned as well, showed to have the highest decrease in purchase of bags and the lowest environmental impact of the researched scenarios. Still, the environmental impact is 112% higher than the current situation (expressed in shadow costs). When the number of carrier bags purchased decrease by 68% compared to the current situation, the environmental impacts were similar to the current situation. This would amount to the purchase of 1 bag (considered for multiple use) per person each month. The impact of litter decreases when implementing any ban on plastic carrier bags. The implementation of reuse of carrier bags has shown to have a significant effect on the results, and the environmental impact of the strictest scenario becomes lower than the current situation. If a ban on plastic carrier bags is implemented, it is recommended that paper bags are banned as well, since they have a high environmental impact. Additionally, carrier bags should never be offered for free, since the study showed that this leads to overconsumption.

Table of content

Summary	3
List of tables and figures.....	6
1. Introduction.....	9
1.1 Response to plastic bag problem	9
1.2 The Netherlands and the city of Utrecht.....	10
1.3 Results for different regulations	10
1.4 Problem definition.....	12
1.5 Research questions.....	13
2. Background and theory	14
2.1 Differences among Tax, Levy and Ban.....	14
2.2 Consumers behaviour.....	14
2.3 Factors influencing implementation of plastic bag legislation.....	15
2.4 Comparison of environmental impact of different carrier bags	15
2.4.1 Life cycle assessment.....	15
2.4.2 Literature review on plastic bags, alternatives and their environmental impact	15
3. Methods	20
3.1 Field research	20
3.2 Survey	20
3.3 Statistics.....	22
3.4 Calculation of number of bags purchased in the city of Utrecht	24
3.4.1 Calculation in the current situation.....	24
3.4.2 Calculation in scenario situation	25
3.4.3 Expansion to the inhabitants of Utrecht	25
3.5 Screening LCA and Littering potential	26
3.5.1 Goal and scope	26
3.5.2 Functional unit and system boundaries	26
3.5.3 Impact assessment methods.....	27
3.5.4 Comparing the environmental impact of different scenarios.....	28
3.5.5 Littering potential.....	28
3.5.6 Comparing littering potential in different scenario situations.....	30
4. Results	31
4.1 Field research	31
4.2 Survey	34
4.3 Number of bags purchased in the city of Utrecht.....	60
4.3.1 Purchase of different carrier bags	60

4.3.2	Comparison of different store types	62
4.3.3	Comparison of different socio-demographic characteristics	63
4.4	Screening LCA and littering potential	65
4.4.1	Screening LCA	65
4.4.2	Littering potential.....	69
5.	Sensitivity Analysis	71
6.	Discussion	75
6.1	Further research.....	79
6.2	Recommendations.....	80
7.	Conclusion	81
	Acknowledgement.....	83
8.	References.....	84
	Appendix A: Survey	88
	Appendix B: Environmental impact of carrier bags.....	97
	Appendix C: Shadow costs.....	98
	Appendix D: Shadow costs of different bags.....	99
	Appendix E: List of stores in the city of Utrecht.....	100
	Appendix F: Extensive table of field research	101
	Appendix G: Statistical tests	104
	Appendix H: Extensive table survey respondents	108
	Appendix I: Survey respondent adjustments.	109
	Appendix J: Most common series Q13, Q20, Q25 and Q30	110
	Appendix K: Consistency Q17, Q22, Q27.....	111
	Appendix L: Difference in survey response by adjustments	113
	Appendix M: Distribution of carrier bags among different stores.....	114
	Appendix N: Distribution of the different bags within the store types.....	115
	Appendix O: Shadow cost per impact category for the different scenarios	116
	Appendix P: Results littering potential.....	117
	Appendix Q: Interview Public service of Wallonia	118

List of tables and figures

Table 1: Effectiveness of plastic bag policies. Source: Nielsen et al. (2019).	11
Table 2: Types of carrier bags.....	16
Table 3: Conversion of survey answers to a percentage of how often a respondent forgets to bring their own bag. This conversion was used for the questions 17, 22 and 27	24
Table 4: Questions used for the calculations of the number of bags in the current situation and scenario situation.	25
Table 5: Inhabitants of the city of Utrecht. Source: WistUdata (2020).....	25
Table 6: Values used for the calculation of the littering potential. In total 15 combination were calculated.	30
Table 7: Results of the field research. The table shows the number of stores visited per store type and in how many of those store a certain type of bag is offered. When a number is between brackets, this means how often a bag is offered for free. E.g. 4 (1) means the bag is offered 4 times of which 1 is offered free of charge.	32
Table 8: Characteristics of bags used in the study.	32
Table 9: Overview of the bags in the different scenarios. Names and prices as used in the survey are shown.	33
Table 10: Q11. If you reuse a bag, how often do you reuse the bags before disposing them? The table shows how often an estimate was filled in (n), the lowest, highest, mean and median value. Next to this, the impact is shown of the highest value filled in.	37
Table 11: Q12. How often do you go to the following stores? (Give your answer in approximate times a month). The table shows the lowest, highest, mean and median value filled in. This is shown for all respondents, and for the male and female respondents separately. When a value is shown in bold, this means that there is a statistically significant difference between the answer given by male and female respondents.	37
Table 12: Q12. How often do you go to the following stores? In this table the different age categories are compared. The mean and median values are shown for the food-retail and department store... ..	38
Table 13: Q14. How many of the bags chosen in the previous question do you need each time that you go to these stores? Mean and median values are shown.	39
Table 14: Consistency between question 34 and 35. The table should be read in rows. Meaning that of the respondents that were positive towards a ban on plastic bags, 2% prefers the current situation etc.	50
Table 15: Total number of bags, percentual change and average per person of the purchased bags in the current situation and scenario situations in the city of Utrecht. The number of bags is shown for each month but the average per person is shown per year. The percentual change is compared to the current situation.....	60
Table 16: Distribution of the number of bags among males and female.	63
Table 17: Percentual change of the total number of bags purchases by males and females. Scenario situations are compared to the current situation.	63
Table 18: Percentual change of the total number of bags purchases by the different age categories. Scenario situations are compared to the current situation.	64
Table 19: Results impact categories for the current situation and the scenario situations. The value between brackets is the percentual change of the value in the scenario situation compared to the current situation.....	66
Table 20: Comparison of different scenarios by using shadow costs. The value between brackets shows the percentual change between the current situation and the scenario situations.	67

Table 21: Shadow costs divided among the different store types. The value between brackets shows the percentage of a stores shadow costs of the total shadow costs.	68
Table 22: Percentual change of the shadow costs for the different stores. The values are compared to the current situation.	68
Table 23: Results of the Littering potential. The table only shows the ranking of the different bags..	69
Table 24: Littering value, based on ranking of different bags.....	70
Table 25: Littering value for current situation and scenario situations.	70
Table 26: Sensitivity analysis when the PP non-woven bags are replaced by the PET bags. The percentual change shows the effect on the shadow costs.	73
Table 27: Sensitivity analysis if paper bags were considered in the supermarket. The PP non-woven bags in the supermarket were replaced by paper bags. The percentual change shows the effect on the shadow costs.....	73
Figure 1: Plastic carrier bag governmental initiatives. Source: Nielsen et al. (2019).....	10
Figure 2: Percentages of types of policies being implemented worldwide. Source: Nielsen et al. (2019).	12
Figure 3: Theory of planned behaviour. Source Ajzen (1991).....	14
Figure 4: Environmental impact, expressed in shadow costs, for multiple use of 150 purchases of 2kg. Source: Boukris et al. (2015).	18
Figure 5: Environmental impact, expressed in shadow costs, for multiple use of 150 purchases of 10 kg. Source: Boukris et al. (2015).....	18
Figure 6: System boundaries from Boukris et al. (2015). The blue boxes are taken into account in their LCA study. Grey is not taken into consideration. Translated and adjusted from Boukris et al. (2015).27	
Figure 7: Survey's respondents socio-demographic characteristics.	34
Figure 8: Q7. Which bag do you have at home? (Left) and Q8. In which store do you get or buy a bag most often? (right)	35
Figure 9: What do you do with your plastic (thin and thicker) carrier bags after using them?	36
Figure 10: Q13. When you go to the following stores, which types of bag do you usually use or buy?	38
Figure 11: Q17. How often do you forget to bring your own bag to a store? This is shown for all respondents, and for the male and female respondents separately.....	41
Figure 12: Q17. How often do you forget to bring your own bag to a Supermarket? Different age categories.	42
Figure 13: Q18. If you forget to bring your own bag which option would you choose? Different store types.	43
Figure 14: Q18. If you forget to bring your own bag, which option would you choose? Supermarket for the different age categories.	44
Figure 15: Q18. If you forget to bring your own bag, which option would you choose? Males and females compared for the department store.	44
Figure 16: Q34. Do you think that a ban on plastic bags in Utrecht is a good idea? Shown for all respondents, and for the male and female respondents separately.....	46
Figure 17: Q35. Which one of the three scenarios do you prefer? Shown for all respondents, and for the male and female respondents separately.	50
Figure 18: Q13, Q20, Q25 and Q30. When you go to the following stores, which types of bag do you usually use or buy? Comparison of the current situation with the scenario situations. Not all options were always available in the different situations.....	51

Figure 19: Q17, Q22 and Q27. How often do you forget to bring your own bag to a store? Comparison of the current situation with the scenario situations.....	52
Figure 20: Percentage how often respondents bring their own bag to the different store types.	53
Figure 21: Q18, Q23, Q28 and Q32. If you forget to bring your own bag, which option would you choose? Comparison of the current situation with the scenario situations. Not all options were available in all situations.	54
Figure 22: Distribution of purchased carrier bags in the different store types.	62
Figure 23: Decrease of number of purchased carrier bags in scenario situations. The values are compared to the current situation.....	63
Figure 24: Distribution of total number of bags between the different age categories.....	64
Figure 25: The required additional decrease of purchase of carrier bags to reach the same environmental impact as the current situation. The blue line represents the level of the current situation. X-axis represents the additional reduction.....	71
Figure 26: The required additional decrease of purchase of carrier bags in the supermarket to reach the same environmental impact as the current situation. The blue line represents the level of the current situation.....	72
Figure 27: Shadow costs of the different scenarios. With and without implementation of reuse of carrier bags.....	74
Figure 28: Percentual change of the shadow costs compared to the current situation. Results are shown when no reuse of the carrier bags is considered, and when the reuse by the median value is implemented.	74

1. Introduction

Until 2016, approximately 3 billion plastic single-use carrier bags are used every year in the Netherlands. This comes down to an average of 170 plastic bags per person each year (Rijksoverheid, 2019a). The plastic carrier bags are a light, convenient and inexpensive way to transport purchased items (Bio Intelligence service, 2011). The first regulation concerning plastic single-use carrier bags was introduced in the Netherlands in 2016, before, these bags were distributed free of charge (Mansveld, 2015). But the plastic bags are already a major point of discussion for over a decade. This discussion emerged from the public, media and legislative pressure in reducing the environmental and social impacts from food packaging and plastic bags (and its alternatives) (Edwards & Fry, 2011). Not only the production of plastic bags is unsustainable due to the raw material use (natural gas or petroleum) and the transportation of the bags (Warner, 2009), but the plastic bags also have strikingly low recycling rates in Europe (Steensgaard et al., 2017). Although there is no exact number for the recycling rate in Europe, it is estimated to be lower than 5% for the US (Nielsen, Holmberg & Stripple, 2019). Also, only 14 % of plastic waste is being collected for recycling globally, compared to 58% of paper and 70–90% of iron and steel (Nielsen et al., 2019). Next to this, the plastic bags can even decrease the performance of automated recycling systems. Additionally, the lightweight of the plastic bags causes it to be a large source of pollution, both on land as in the oceans, and because of the durability of the bags it takes hundreds of years to decompose (Xanthos & Walker, 2017). In the ocean, plastic bags have shown to be an important source of the marine plastic pollution, better known as the plastic soup. This plastic soup affects marine life with entanglement of species, causing suffocation of the animals (Xanthos & Walker, 2017). But not only animals are affected by this pollution, challenges also occur with economic development. For example, by reduced tourism due to plastic pollution on shorelines, vessel damage and damage to public health (Hardesty, Good & Wilcox, 2015). Lastly, a large part of the litter found in catch basins and drain inlets of stormwater management systems are plastic bags, which damages these systems (Wagner, 2017).

1.1 Response to plastic bag problem

Already for over a decade, there has been a worldwide response to the plastic bag problem. In contrast to many other plastic objects (such as textiles or tyres), plastic bags often consist of one type of plastic (mostly polyethylene) and many alternative carrier bags are available. Therefore, regulation of plastic carrier bags is less complicated and difficult (Nielsen et al., 2019). Different types of regulations on the plastic bags were developed, ranging from bans and levies to agreements on providing information about the environmental impact of the use. Next to this, non-state initiatives were developed which helped spreading the public policies (e.g. Voluntary agreements, public sponsored information campaigns and Extended Producer Responsibility) (Nielsen et al., 2019). In Figure 1, the worldwide situation of August 2018 is shown in terms of their policy of plastic bag use. It can be observed that in Europe almost all countries have a policy concerning plastic bags, this is due to the EU directive on light weight plastic bags 2015/720. This directive is the first intergovernmental policy measure that puts constraints on the use of plastic (European Parliament and the Council, 2015). Next to this, it can be observed that mainly in the global South, bans of plastic bags are implemented, which is seen as a stricter regulation. Knoblauch, Mederake & Stein (2018) explain this with the fact that in the global North there is a strong organized civil society. Therefore, there is a big global public pressure, which also includes awareness raising campaigns from NGOs such as Greenpeace. While in the global South, the pressure comes from actual national problems, such as the fact that the plastic litter is much more visible and harmful due to limited waste collection and recycling rates.

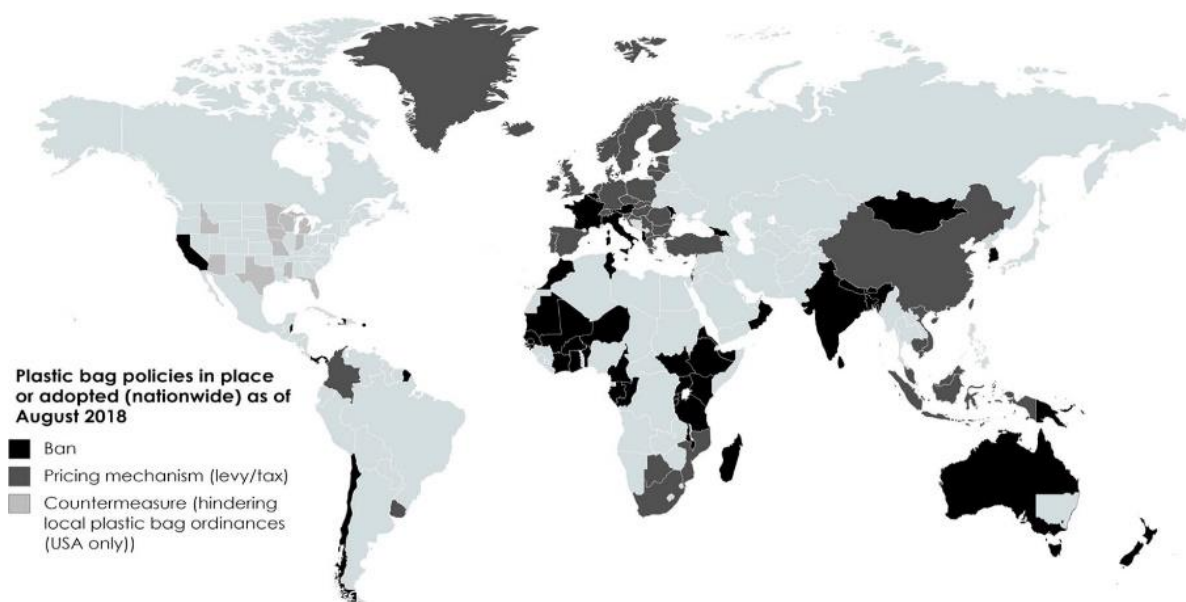


Figure 1: Plastic carrier bag governmental initiatives. Source: Nielsen et al. (2019).

1.2 The Netherlands and the city of Utrecht

Since the 1st of January 2016, plastic bags are not distributed for free in the Netherlands. Instead, a levy was introduced for the all plastic bags to ensure a reduction of the plastic bag use. The levy for the bags varies between 0.10 – 0.25 ct per bag. Exception is made for bags required to ensure functionality and food safety, but these bags must be thinner than 15 μm (Mansveld, 2015) (Rijksoverheid, 2019b). On the 2nd of March 2020, I&O Research published an evaluation on the effectiveness of the levy on plastic carrier bags, this evaluation was performed by I&O research. In this evaluation the consumers experience, if rules are complied with and the effectivity of the ban was evaluated. It was shown that the number of distributed plastic carrier bags decreased with 80% in 2018 compared to 2015. Meaning that the use of plastic bags reduced from 170 bags per person each year to 35 bags. Alternatives such as single-use paper bags are still distributed for free. In 2018, the number of distributed plastic carrier bags was approximately 600 million bags. Currently in the city of Utrecht (the 4th largest city in the Netherlands) a ban on plastic bags is being considered by several political parties of the municipality.

1.3 Results for different regulations

Statistics on the outcome of various plastic bag regulations are shown in Table 1 (Nielsen et al., 2019). This table shows the country, policy type and effect of the different policy type. Although, banning of plastic carrier bags is the most frequently used policy instrument across the world for controlling plastic bag usage (Figure 1, Figure 2), less information is available about the outcome of a plastic bag ban. This is due to a lack of accurate data on (single use) plastic bag production, plastic waste, waste collection and recycling rates (Nielsen et al., 2019; Knoblauch et al., 2018). Additionally, an exact number for the possible long-term effect of plastic bag levies is not known. An example of the long-term effect can be found in Ireland. After the introduction of a levy on the plastic bags, their plastic bag use showed a reduction of 90%, from 328 plastic bags per person per year, to 21 bags. But after 6 years, the yearly bag use increased to 31 pieces per person. After this increase it was decided to increase the levy paid from 0,15ct to 0,22ct per bag (Wagner, 2017). The ban or levies on plastic bags can also cause rebound effects related to the purchase of other type of plastic bags. A good example can be found in Portugal. A study performed by Martinho, Balaia & Pires (2017) showed that after the implementation of a levy

on plastic bags, the reduction of plastic bag consumption was estimated to be 74%. Simultaneously, the increase of reusable plastic bags was estimated to be 61% and the consumption of garbage bags showed an increase of 12%. This increase of reusable plastic bags and garbage bags is the rebound effect. An explanation for the increase of the garbage bags is because a lot of the plastic carrier bags are typically used as a garbage bag after use.

Unfortunately, policy options also raise some problems. For example, it is difficult to determine what should be the price of the bags without people with different income being affected unfairly. Additionally, for the bans, no worldwide consensus exists for which plastic bags the ban holds. For example, France, Italy and San Francisco decided not to include biodegradable plastic bags in their ban. Also, a difference is made between the thickness of the plastic bags. In the Global South, the focus of the restrictive policies is on very thin plastic bags (thinner than 30 μm). While in the EU Directive, the focus is on bags between 15 – 50 μm . Bags thinner than 15 μm are excluded for hygienic purpose of primary packaging of products, or when the bag can avoid food waste. Bag thicker than 50 μm are considered multiple-use bags and are therefore excluded (European Parliament and the Council, 2015).

Table 1: Effectiveness of plastic bag policies. Source: Nielsen et al. (2019).

Country (Year of implementation)	Policy type	Effect (reduction in consumption in %)
Denmark (1994)	Tax	66% (Ritch et al., 2009; Dikgang et al., 2012)
Bangladesh (2002)	Ban	No noticeable effect (lack of implementation) (Larsen and Venkova, 2014)
Ireland (2002)	Levy	More than 90% (Convery et al., 2007)
South Africa (2003)	Partial ban + levy	Initially 80%, after increased sales 44%, with further sales increases expected (Hasson et al., 2007; Dikgang et al., 2012)
Belgium (2003; 2007)	Tax + voluntary fee	86% between 2003 and 2011 (Larsen and Venkova, 2014) 60–80% (Martinho et al., 2017)
Botswana (2007)	Partial ban + levy	50% (Dikgang and Visser, 2012)
China (2008)	Partial ban + fee	49% (He, 2012)
Hong Kong (2009)	Fee	75% (Larsen and Venkova, 2014)
Washington D.C. (2010)	Levy	80% (Romer and Foley, 2011)
Santa Barbara, CA (2013)	Ban on plastic bags + levy on paper bags	89.3% on all type of bags (Wagner, 2017)
Wales (2011), Northern Ireland (2013), Scotland (2014)	Levy	Around 80% (Poortinga et al., 2016)
England (2015)	Levy	85% (Poortinga et al., 2016)
Portugal (2015)	Tax	74% (Martinho et al., 2017)

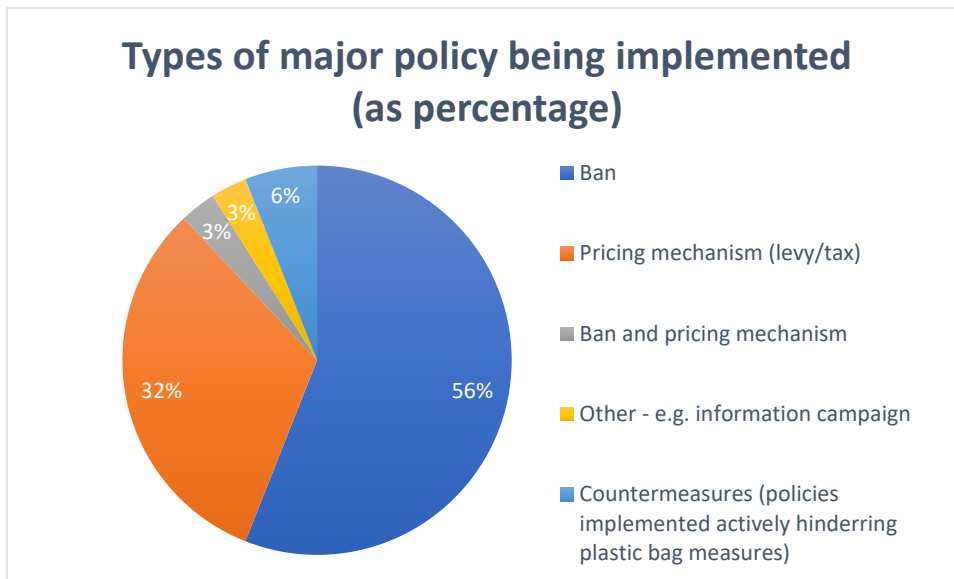


Figure 2: Percentages of types of policies being implemented worldwide. Source: Nielsen et al. (2019).

1.4 Problem definition

Some research has been performed on the impact that plastic bag regulations have after implementation on the consumption of plastic bags. It has been shown that regulations cannot be overall used, and the outcome of implementation is different depending on the country (Kasidoni, Moustakas & Malamis, 2015). Most of the existing studies only reported the change in plastic bag consumption due to the regulation, while the change of consumption of other bags (such as paper bags) were not considered, or only estimated. However, to determine whether the implementation of a certain regulation for plastic bag leads to environmental benefits, the consumption of other carrier bags should be considered as well. Especially since it has been shown that other alternatives (e.g. paper bags) can have high environmental impact (Boukris, Gijlswijk, Ansems & Jongeneel, 2015; Bisinella, Albizzati, Astrup & Damgaard, 2018; Edwards & Fry, 2011). Thus, the regulation could lead to negative consequences by having an environmentally less desirable and/or more expensive product (Wagner, 2017). Next to this, it also has never been shown how the environmental impact could change at a city scale after the implementation of a regulation on plastic bags.

The success of a ban in plastic bags is highly influenced by the consumer choices and behaviour. However, only a few studies were found regarding consumers behaviour change after implementation of plastic bag regulations. A study by Sharp, Høj & Wheeler (2010) investigated the consumers behaviour regarding the use of plastic bags, by estimating the amount of times that consumers buy a bag from the store or bring their own bag. This study dates from 2010 and was performed in Australia. Since then, a lot more awareness is created for the use of plastic bags and way more regulations have been implemented. Because of this, the same study could now give completely different results. In Portugal a study by Martinho and colleagues (2017) was performed on the effect of a plastic bag tax on consumers behaviour. This was done with a survey filled in by consumers before and after the implementation of the tax. The study did not give data about other bags used to replace the single-use plastic bags (it was only mentioned that paper and textile bags are other options).

As mentioned before, several political parties of the municipality of Utrecht are considering a ban on plastic bags. However, the municipality has no clear image about what the environmental

consequences would be after implementation of this ban. Therefore, this study explored the environmental impacts of implementing different regulations concerning plastic bags in the city of Utrecht. This was done by performing a consumer's behaviour study and by assessing the potential environmental impacts caused by a ban. A recommendation for the implementation of a ban on plastic carrier bags is provided.

1.5 Research questions

The following research question and sub-questions were determined

1. What would be the environmental consequences of banning all plastic carrier bags in the city of Utrecht?

a. What is the current situation in the city of Utrecht, in terms of plastic bag consumption and consumption of alternative bags?

b. How would consumers' behaviour change in Utrecht when banning plastic carrier bags, in three scenarios?

c. How do the three scenarios compare to the current situation from an environmental perspective?

In this research a study was performed in the city of Utrecht, where the current situation was compared with three potential scenarios. The study only considered the plastic bags and alternatives that can be bought in stores for the use of carrying home purchased goods. The three scenarios are:

Scenario 1. *Soft policy*, all plastic bags that are considered to be used less than 6 times will be banned. All the other options will remain the same.

Scenario 2. *Medium policy*, all plastic bags that are considered to be used less than 6 times will be banned and a pricing mechanism will hold for all the single-use non-plastic alternatives that are offered for free.

Scenario 3. *Hard policy*, all plastic bags that are considered to be used less than 6 times will be banned and all single-use carrier bags will be banned.

2. Background and theory

2.1 Differences among Tax, Levy and Ban

The terms for different types of regulations to control plastic bag use are often mixed up in the literature. According to an online law dictionary, a tax is defined as “a governmental assessment (charge) upon property value, transactions (transfers and sales), licenses granting a right and/or income” (Tax, 2019). The government can spend the collected tax money in any investment. A levy, on the other hand, is a type of tax that is collected by the government for a certain purpose. For example, a levy could be collected for environmental management. Next to this, there is also a fee as pricing mechanism. A fee does not have to be collected by the government but is to provide a service that benefits the group of people from which the money is collected. Lastly, the term ban also gets different meanings in literature. Although one would expect that a ban on plastic bags would mean a complete removal of the bags, this is not always the case. In the Netherlands for example, plastic bags are not handed out free of charge anymore, but a certain amount needs to be paid for the bag. This regulation is then a levy on plastic bags but is promoted as a ban on free plastic bags. In this thesis, the term ban refers to a complete forbidding of the bags.

2.2 Consumers behaviour

Predicting the change in consumers behaviour is generally complex. A widely used theory on the change of consumers behaviour is “the theory of planned behaviour”, which gives a theoretical model to predict people’s behaviour (Ajzen, 1991). It shows that human behaviour is not only based on personality traits, but also on how personal intentions create the willingness of performing certain behaviour. Next to this, there are three main factors influencing someone’s intentions. First, the perception of behavioural control influences intention, which is the perception of people’s ability to perform a certain behaviour (the perceived ease or difficulty). Secondly, the perceived social pressure to perform a certain behaviour influences people’s intention, named the perceived (subjective) norm. Lastly, someone’s attitudes towards certain behaviour influence the intention (e.g. environmental attitudes). The theory is represented in Figure 3. Non-motivational factors (e.g. time, money, skills, cooperation of others) influence the control of the behaviour.

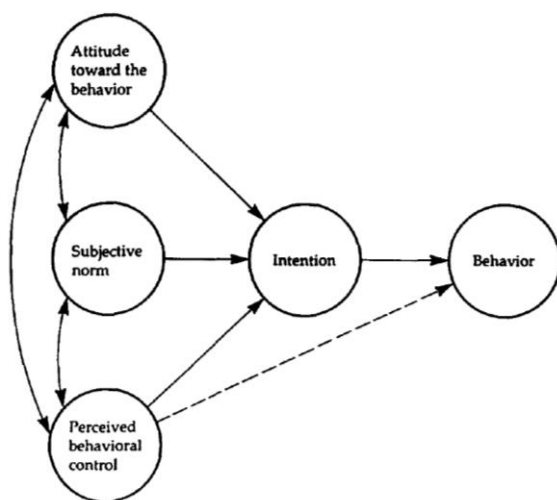


Figure 3: Theory of planned behaviour. Source Ajzen (1991).

2.3 Factors influencing implementation of plastic bag legislation

Studies performed on consumers behaviour and acceptance on regulations for plastic bag use indicated some resistance when the legislations were implemented. This resistance faded as time passed (He, 2012). Also, the public opinion affects effectiveness of implemented legislations, whereby this public opinion is affected by social factors. A study performed by Li & Zhao (2017) showed that the order of social factors that influence consumers behaviour in environmental problems (such as plastic bag use) is; cost of living > educational attainment > level of economic development > geographical location > interest of industry. An explanation for this order is that many environmental problems do not damage an individual directly and is therefore not one's top priority. Survival is considered more important, making the cost of living the most important social factor (Li & Zhao, 2017). This is also supported by another study performed by Jakovcevic and colleagues (2014), this study states that most of the implemented regulations for plastic bag use are not supported due to financial reasons. They also state that more awareness is created by putting a levy on the plastic bags. This awareness activated environmental motives for consumers to bring their own shopping bag. This shows the importance of implementing regulations together with good campaigning and information about environmental benefits (Jakovcevic et al., 2014). Additionally, Kasidoni and colleagues (2015) showed that it is difficult to determine which regulation is best for a country, since no single solution can be overall used.

2.4 Comparison of environmental impact of different carrier bags





2.4.1 Life cycle assessment





"A Life Cycle Assessment serves as a worldwide approved framework used for making sustainability decisions" (Jolliet et al., 2015). By the performance of a LCA study, the environmental impact of a product or service is evaluated. In the assessment, all life cycle stages are taken into account. And the outcome of the assessment shows where environmental improvement can be performed in the life cycle stages (Jolliet et al., 2015). For an LCA study it is important to include multiple life cycle impact categories. This is done in order to avoid shifting the burdens from one impact category to another (Flanigan, Frischknecht & Montalbo, 2013).

2.4.2 Literature review on plastic bags, alternatives and their environmental impact

Several types of carrier bags in the Netherlands exist. These bags are made from different material types. Different studies investigated the environmental impact of different types of carrier bags. Two studies by Bisinella et al. (2018) and Boukris et al. (2015) provide life cycle assessments performed on the different types of carrier bags used in The Netherlands. The types of bags, with an image, amount of times used, and some additional information are shown in Table 2.

Table 2: Types of carrier bags.

Bag type	Image	Amount of times used	Additional information
<i>High-density polyethylene (HDPE) bags</i>	 <p>Source: Bisinella et al., (2018).</p>	Single-use	These bags are made from melting HDPE, shaped into the form of a bag (Bisinella et al., 2018).
<i>Low-density polyethylene (LDPE) bags</i>	 <p>Source: Boukris et al. (2015).</p>	Multiple use, approximately 5 times.	These bags are made from melting LDPE, shaped into the form of a bag (Bisinella et al., 2018).
<i>Polypropylene (PP) bags</i>	 <p>Source: Boukris et al. (2015).</p>	Multiple use, approximately 75 times.	These bags are made from PP fibers. This can either be woven or spun bonded. The bags are stronger, more durable and bigger than LDPE and HDPE bags (Bisinella et al., 2018).
<i>Polyester (PET) bags</i>	 <p>Source: Bisinella et al. (2018).</p>	Multiple use, approximately 75 times.	These bags are made by weaving polyester fibres (polymer type PP or PET). In general, these bags are very light and thin (Bisinella et al., 2018).

<p><i>Biopolymer bags</i></p>	 <p><i>Source: Bisinella et al. (2018).</i></p>	<p>Single-use</p>	<p>The Biopolymer bags can either consist of polylactic acid (PLA), bio-polyethylene (bio-PE) or a starch blend. Under the right circumstances these materials are compostable (Bisinella et al., 2018). But the biodegradability of these materials is being argued by scientists (Napper & Thompson, 2019). Some of the materials are namely only biodegradable in certain facilities (where still parts of the plastic can be remaining) and not in natural environments.</p>
<p>Paper bags</p>	 <p><i>Source: Bisinella et al. (2018).</i></p>	<p>Single-use</p>	<p>The bags are made of craft paper (Bisinella et al., 2018).</p>
<p>Textile bags</p>	 <p><i>Source: Bisinella et al. (2018).</i></p>  <p><i>Source: Paardekooper (2019).</i></p>	<p>Multiple use, approximately 75 times.</p>	<p>These bags can be made of woven cotton or jute (organic or not) (Bisinella et al., 2018).</p>

The study performed by Boukris and colleagues (2015) evaluated the carrier bags in terms of their environmental impact by performing a life cycle assessment of the different types of carrier bags. A distinction is made between the carrying of 2kg of groceries for one year (150 times) and 10 kg of groceries. All the material types mentioned in section 2.3.1 are evaluated in this study. Also, different sizes of the bags are considered and the approximate amount of times a certain bag can be used is taken into account. The results were determined considering shadow costs. Shadow costs are used to weigh different impact categories so that they only have one single indicator, in this case, costs necessary to compensate for the impact category. The results are shown in Figure 4 and Figure 5. What can be seen is that, although now paper bags are promoted as more environmentally friendly, these bags score worst in their environmental impact, while, the plastic LDPE bags score quite low in their environmental impact.

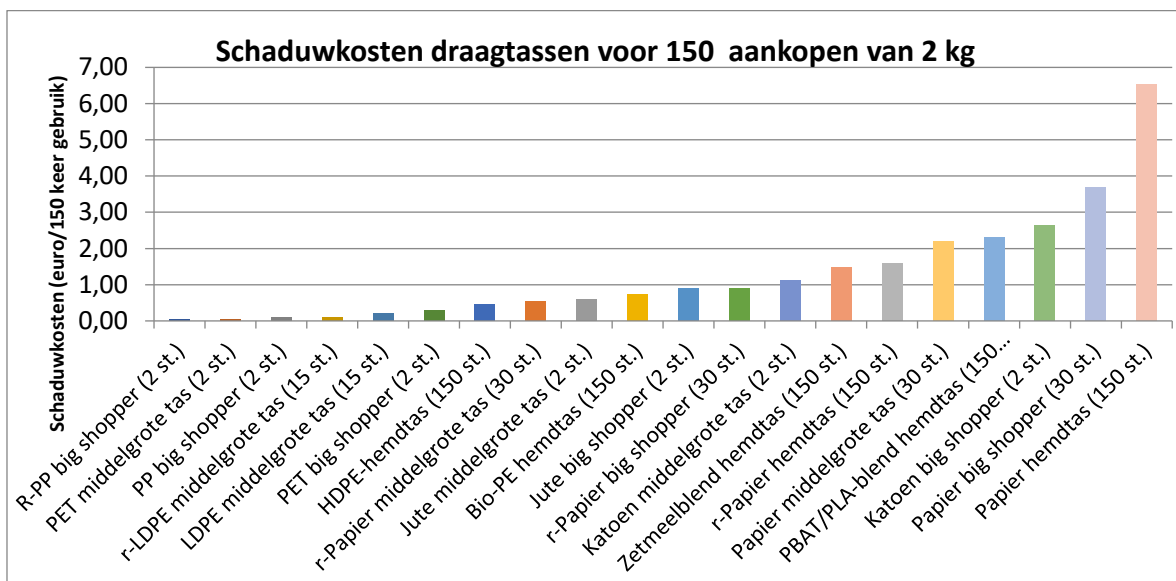


Figure 4: Environmental impact, expressed in shadow costs, for multiple use of 150 purchases of 2kg. Source: Boukris et al. (2015).

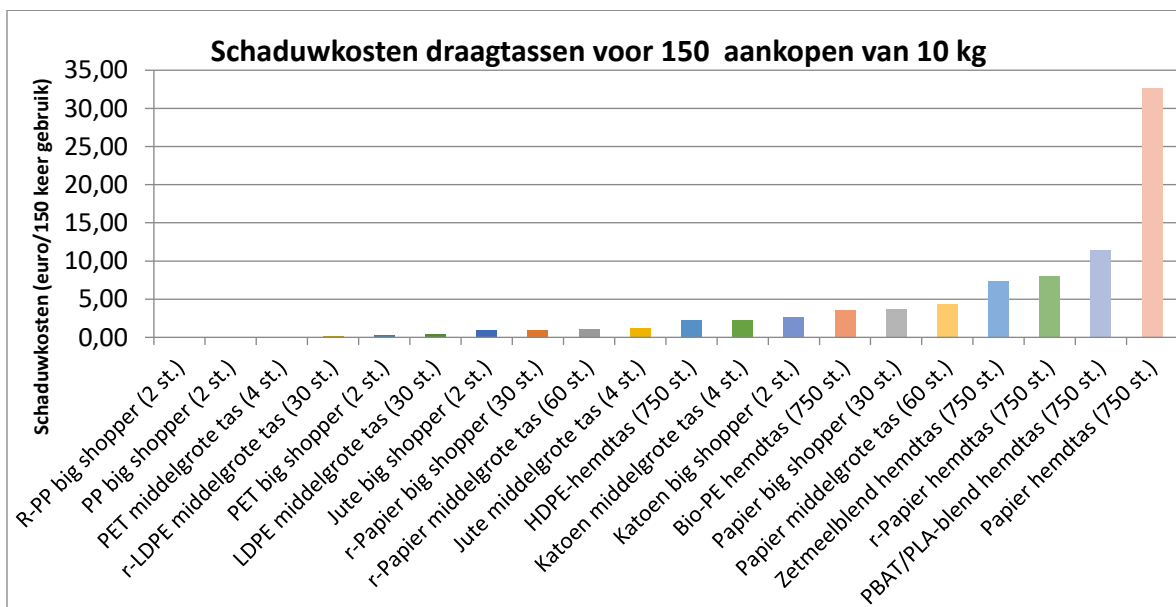


Figure 5: Environmental impact, expressed in shadow costs, for multiple use of 150 purchases of 10 kg. Source: Boukris et al. (2015).

Similar results were found in the research performed by Bisinella and colleagues (2018). Which showed that overall, the LDPE carrier bags had the lowest environmental impact for most of the impact categories studied. But for heavier carrier bags, like PP and PET bags, the bags need to be reused multiple times to lower the environmental production costs. They also determined the amount of times bags needed to be reused to lower the environmental impact at the level of a LDPE bag. For a Cotton bags this was estimated in 149 times. One notable outcome from this study compared to the study performed by Boukris and colleagues (2015), is that the paper bags do not score as low. For the indicator climate change, unbleached paper bags score the lowest impact of all bags.

Edwards and Fry (2011) also performed a LCA study on the carrier bags in Bristol. Again, HDPE bags showed the lowest environmental impact. Where paper, LDPE, PP and cotton bags should be reused at least 3, 4, 11 and 131 times to reach similar levels of global warming potential as HDPE bags. The authors clearly state the importance of reusing carrier bags.

Lastly, Muthu, Li, Hu and Mok (2012) studied the impact of the usage of paper and plastic carrier bags. They investigated this by considering the consumers behaviour and governmental policies. This was done in three different scenarios: existing behaviour and policies, behaviour according to consumers perception and the last scenario is a scenario in which no recycling systems were provided by the government. Again, plastic bags scored lower than paper bags. Their main conclusion is to lower the environmental impact as much as possible, the carrier bags should be reused till they are discarded. The presence of recycling systems also reduced the eco-impact.

Most of the reviewed studies indicate better environmental performance from plastic bags than for other alternatives. However, the LCA methodology at the moment is not able to provide information on the environmental impacts related to littering, which is one of the main reasons to implement bans on single-use plastic bags. Lewis, Verghese and Fitzpatrick (2010) state in their study that no reliable data is available about the degradability of different materials and therefore, the ecological and ethical issues associated impacts cannot be analyzed (including the potential hazard to wildlife). A study performed by Civancik-Uslu, Puig, Hauschild and Fullana-i-Palmer (2019) introduced a littering indicator that enabled to compare the littering impact of different type of bags. Still, no absolute impacts were created, but the relative risk of bags to end up as litter into the environment is compared. In their study HDPE, LDPE, Paper, PP and biodegradable bags were included. It was concluded that an HDPE bag has the highest littering potential followed by the LDPE bag, the PP bag had the lowest potential.

3. Methods

In order to answer the research question, the research consisted of several steps. As a first step, the type of stores most present in the city of Utrecht and the type of carrier bags used in the city of Utrecht were identified through a field research. As a next step, a survey was conducted to identify the current carrier bag use, and the use in the proposed scenario situations (defined in Section 1.5). On the survey results, several statistical tests were performed. As the last step, a screening LCA was performed to examine the environmental impact of the current situation and proposed scenario situations. In this screening LCA also a recent method was used to determine a littering potential of different bags and scenarios.

3.1 Field research

The first step of the field research was to determine which type of stores are present in the city of Utrecht. Firstly, a selection of store types was made based on the information on the websites “Indebuurt” (2019) and “Bezoek-Utrecht” (2019). “Indebuurt” is a website from a “city magazine” of the city of Utrecht, that provides an overview of the shops in the city of Utrecht. “Bezoek-Utrecht” is an official website of the Tourist Information Office and provides an overview of the shops in the city centre of Utrecht. The second step of the field research was to determine the different types of carrier bags used in the city. This was done by visiting, at least, 10 shops per store type and asking which carrier bags they offer and (if necessary) how much they charged for each. From this data set, the types of bags per store type were determined as well as their average size and price for the consumer.

3.2 Survey

To explore the effect a ban on plastic bags would have on consumers’ behaviour, a survey was conducted among consumers in the city of Utrecht. The data collection took place between the 16th of October 2019 and the 4th of November 2019. The survey was available on paper and online in both English and Dutch. For the digital version, the software Qualtrics was used, provided by the University of Utrecht. All responses to the survey were documented and processed in Excel. Statistics were performed using the programme SPSS.

The target population of this study are consumers in the city of Utrecht. Since the author is a resident in Utrecht, it was decided to make use of the local ties and distribute the survey to the social circle of the author. Additionally, the survey was made available in several public locations in the city of Utrecht such as supermarkets, stores and community centres. Furthermore, the survey was published on social media platforms, such as Facebook and LinkedIn.

The survey comprised 39 questions (22 multiple choice questions and 17 open questions) split into four sections. The complete survey can be found in Appendix A: Survey and each question will be discussed in the result Section 4.2.

The first part of the survey addressed sociodemographic characteristics such as age, gender and education level. This was asked to see whether these characteristics influenced the survey response, and to extrapolate the survey responses to the size of the city of Utrecht. It was also asked whether respondents lived in a city, lived in Utrecht or went shopping in the city of Utrecht. These answers were used to determine whether the data from the questionnaire could be included in the study. When a participant did not live in a city, did not live in Utrecht and never went shopping in Utrecht, the survey

response was not considered. Based on data from this first section, it was evaluated to which extent the study participants represented the inhabitants of the city of Utrecht.

The second and third survey section was aimed at understanding more about people's choices between different types of carrier bags. When designing the survey questions, very common bag types were chosen resulting from the field research. Each bag type was also displayed with a picture to ensure a clear, consistent understanding in participants which type of bag was meant. The questions in the second section revolved around survey participants' current shopping behaviour and current carrier bag use for four different store types (supermarket, food-retail, clothing store and department store, determined by the field research).

In section three of the survey, three questions from section two were repeated, but embedded in the three different scenarios described in Section 1.5. First, it was asked which bag was typically used when going to a certain type of store. Next, inquiring potential behavioural changes after implementing a ban on plastic carrier bags, people were asked "*How often do you think you would forget to bring your own bag to a store in this scenario?*". Lastly, it was asked which alternative bag option people would choose if they did forget to bring their own bag. Available options changed in the different scenarios, and the costs of purchasing an alternative bag were displayed along.

Comparing the answers of the second and third part of the survey allowed to determine how the purchase of carrier bags would change between the current situation and the three scenario situations. In the fourth part of the survey, the aim was to capture people's opinions on banning plastic bags, their preferences between different scenarios, and their motivation to bring (or not to bring) their own bags. Respondents were also asked whether they had an idea how to reduce the use of plastic carrier bags, other than with a ban. These topics were covered using multiple choice and open questions. The answers on these questions can indicate whether the implementation of a ban would face high resistance from consumers in the city of Utrecht.

Taken together, the answers to the survey were used to estimate the current carrier bag use in Utrecht, and how it might change under different plastic bag regulations. By using this method, the theory of planned behaviour, as explained in Section 2.2, was followed since the intention of the survey respondents was used to predict future behaviour. The sociodemographic data was used to extrapolate survey results to the whole population of Utrecht.

3.3 Statistics

Sociodemographic characteristics could influence the answers of survey participants. Therefore, statistical tests were performed on some questions to see if there are significant differences related to sociodemographic data, and people's choice of carrier bag use. These tests determine which sociodemographic characteristic are important to consider when calculating the monthly carrier bag use for the city of Utrecht (Section 3.4). The statistical tests were conducted in SPSS Statistics version 25.

Statistical tests were performed on the questions 12, 13, 14, 17, 18, 34 and 35. The first aforementioned five questions were chosen because the current carrier bag use was calculated based on them (explained in Section 3.4). Therefore, the statistical tests showed which characteristics were to include in the calculation. Questions 34 and 35 could show if there are certain sociodemographic characteristics which are related to higher support or opposition to a ban on plastic carrier bags. In total, three types of statistical tests were performed. For all tests, the level of significance was set at 0.05.

Independent sample t-test

The independent sample t-test (Mooi, Sarstedt & Mooi-Reci, 2018; Salkind, 2000) was performed to see if there were different responses between male and female survey participants. The t-test shows whether two groups have a statistically significant difference between the means of the groups (i.e., the difference is so large that it is unlikely to have occurred by chance). This corresponds to a 5% error probability. When the result from the t-test (p-value) is ≤ 0.05 , the difference between the groups is considered significant.

ANOVA test

The ANOVA test is performed to show whether there is a difference between three or more groups (Mooi, et al., 2018), therefore this test could be used to show differences between the age groups and educational level. In an ANOVA test, the mean of answers between groups is compared. Hence, this test was performed on questions where respondents were asked to fill in a numerical value, such as in question 12. When the outcome of the ANOVA test (p-value) is ≤ 0.05 , it means that there is a statistically significant difference between the groups. A requirement to conduct an ANOVA test is that there is no violation of the homogeneity of variance. Therefore, the test of homogeneity of variance is performed before the ANOVA test. When there is a violation of homogeneity of variance ($\sigma \leq 0.05$), the ANOVA test is replaced by a Welch test. When the outcome of the Welch tests (p-value) is ≤ 0.05 , it shows a statistically significant difference between the groups (Mooi, et al., 2018; Salkind, 2000; Quirk, 2018).

Chi-square test

Lastly, Chi-square tests were performed. In a Chi-squares test, frequencies of answers are compared between two or more groups (Mooi, et al., 2018; Salkind (2000); Schneider, 2009). Therefore, this test could be used to compare the answers of the multiple-choice questions. With these tests, answers of the different age groups and educational levels are compared. Again, when the p-value of the test is ≤ 0.05 , it shows a statistically significant difference between the groups. A Chi-square test requires a minimum expected count. Therefore, groups had to be put together to meet this condition. For example, in questions 34 the options were "Very good", "Good", "Neutral", "Bad" and "Very bad".

Because the condition was violated in this question the options “Very good” and “Good” and the options “Bad” and “Very bad” were combined. In this case, positive responses, neutral responses and negative responses were then compared with the Chi-square test. This was sometimes also the case for the bag types (depending on the distribution of survey answers). In that case plastic bags (thin and thicker¹) were compared with paper bags, the bags for multiple uses (fabric shopper, plastic shopper, foldable bag, jute and cotton) and other option than purchasing a bag (I bring my own bag or other option). And lastly, in some cases, the three lowest levels of education were combined and compared to the other levels of education as one group.

¹ The carrier bags were titled differently in this study and the survey. In Section 4.1 these different titles are shown.

3.4 Calculation of number of bags purchased in the city of Utrecht

The statistical tests, explained in Section 3.3, showed which sociodemographic characteristic had some influence on the survey results. Therefore, these characteristics should be considered when the survey results are expanded to the inhabitants of Utrecht. One exception was the category “level of education”. Since respondents were unequally distributed between the different levels of education, no conclusions for the whole population could be drawn from these data. Therefore, the level of education of the respondents was not considered in the calculations of the number of bags purchased in Utrecht.

3.4.1 Calculation in the current situation

After asking respondents about their behaviour regarding bag use in different stores, the next step was to calculate how the consumption of bags would change under different scenario situations. For that calculation, the amount of newly purchased bags was per person and month in each scenario was estimated. First, the answers of respondents were cross categorised for the 2 genders, the 6 age categories and the 4 types of shops. This gives a total of 48 groups. Then, for each group the following method² was used to calculate the number of bags:

$$\text{the number of bags} = \sum_{i=1}^n (Q12_i * Q14_i * Q17_i)$$

where:

Q12 = Number of times respondents went to a store each month

Q14 = Number of bags they use each time they go to a store

Q17 = Percentage how often respondents forget to bring their own bag

and n the total amount of types of bags (8 for the current situation).

The answer to question 18 determined the bag type. The result of the calculation gave the number of bags of each bag type for the 48 groups.

In question 12 and 14 the respondents filled in a numerical value, while question 17 was a multiple-choice question. Therefore, the answer to question 17 was converted into a percentage. In Table 3 the conversion of question 17 is shown.

Table 3: Conversion of survey answers to a percentage of how often a respondent forgets to bring their own bag. This conversion was used for the questions 17, 22 and 27

Multiple choice option	Converted percentage
Never	0%
Less than half of the time	25%
Half of the time	50%
More than half of the time	75%
I never bring my own bag	100%

With this conversion, the average amount of time people bring their own bag was also determined.

² Initially, two methods were used for the calculation. In the other method, the answers to questions 12 and 14 were multiplied to determine the number of bags purchased per month. The answers to the questions 13, 20, 25 and 30 (“Which bag do you usually use?”) were used to determine the type of bag. However, it became apparent that a lot of the respondents interpreted question 13 wrong (because respondents sometimes explained which bag they use in answering question 15, 21, 26 or 31). It was thus decided to only use the method described above for further calculations.

3.4.2 Calculation in scenario situation

To calculate the number of bags purchased in the scenario situations the same steps as for the current situation were taken. But in this case, some questions were replaced by the questions in the scenario situations. The questions used for each situation are shown in Table 4. Questions 22 and 27 were converted into percentages in the same way as in question 17. The number of bag types (n) also changed in the scenario situation.

Table 4: Questions used for the calculations of the number of bags in the current situation and scenario situation.

	How often do you go to the following store?	How many bags do you need?	How often do you forget to bring your own bag?	Which alternative do you use, when you forget to bring your own bag?	n
Current situation	Q12	Q14	Q17	Q18	8
Scenario 1	Q12	Q14	Q22	Q23	6
Scenario 2	Q12	Q14	Q27	Q28	6
Scenario 3	Q12	Q14	Q27	Q32	5

3.4.3 Expansion to the inhabitants of Utrecht

The results were then expanded to the number of inhabitants in Utrecht. The number of inhabitants was taken from WistUdata (2020), shown in Table 5.

Table 5: Inhabitants of the city of Utrecht. Source: WistUdata (2020).

Inhabitants in the city of Utrecht			
Age	All	Male	Female
<15	60073	30628	29445
15 -25	62563	28011	34552
26 -35	74118	36581	37537
36 - 45	49611	25323	24288
46 - 55	42599	22186	20413
56 - 65	29825	14947	14878
65+	34152	15237	18915
Total	352941	172913	180028

The results were expanded for all the groups separately. This was done by taking the number of males or females in a certain age category and dividing this by the number of participants of the survey in that age category. The resulting factor was then multiplied with the results of the survey. For example, in the survey there were 74 female respondents between the age of 26 to 35. The city of Utrecht has 37,537 female inhabitants in this age range. Therefore, the results from the female respondents in the age category 26 -35 were multiplied with a factor 507.26 ($37537/74 = 507.26$).

3.5 Screening LCA and Littering potential

3.5.1 Goal and scope

The goal of the study was to compare the environmental impact of the current use of carrier bags in the city of Utrecht with the potentially changed environmental effect in three different scenarios. The aim was to evaluate whether the implementation of different legislations concerning plastic carrier bags would show environmental benefits. The target group for the survey were consumers in the city of Utrecht. Therefore, the collected data was extrapolated to city scale and the intended audience of the study is the municipality of Utrecht.

3.5.2 Functional unit and system boundaries

The functional unit chosen for this study was “Carrying of purchased goods from supermarkets, food-retail, clothing and department stores, by consumers in the city of Utrecht to their home, over the period of one month”. Specific attention was paid to how often consumers forget to bring their own bag and therefore purchase a new carrier bag. To fulfil this functional unit, the analysed products are carrier bags provided in the city of Utrecht. Since the approach of this LCA is consequential, only the change in consumption of bags was considered (i.e. new purchase of bags under different situations with respect to the present). It was assumed that all carrier bags except paper bags were produced from virgin materials. For the paper bags, it was assumed that 75% of the paper bags were produced from recycled material (Laurijssen, Marside, Westenbroek, Worrell & Faaij, 2010).

LCA studies on different types of carrier bags were already performed by Bisinella et al. (2018) and Boukris et al. (2015). Therefore, a consequential screening LCA (using secondary data) was performed. Boukris et al. (2015) focused in their research on the Netherlands, so this study used the results of this previous study as the main source. In the data taken from Boukris et al. (2015), the reuse of carrier bags as well as single use of different bags was considered. The data that considered single use allowed that the results to their study could be multiplied with the number of bags, as determined in Section 3.4. The values used for this calculation can be found in Appendix B: Environmental impact of carrier bags.

The LCA performed by Boukris and colleagues (2015) was a cradle to grave LCA, and a ReCiPe midpoint methodology was used. The following processes were included in their study:

- Extraction of raw materials
- Production of materials
- Production of carrier bags
- Use of the carrier bags
- Reuse of the carrier bags
- Recycling of the carrier bags
- End-of-life of the carrier bags
- All transports in between

These processes are also represented in Figure 6.

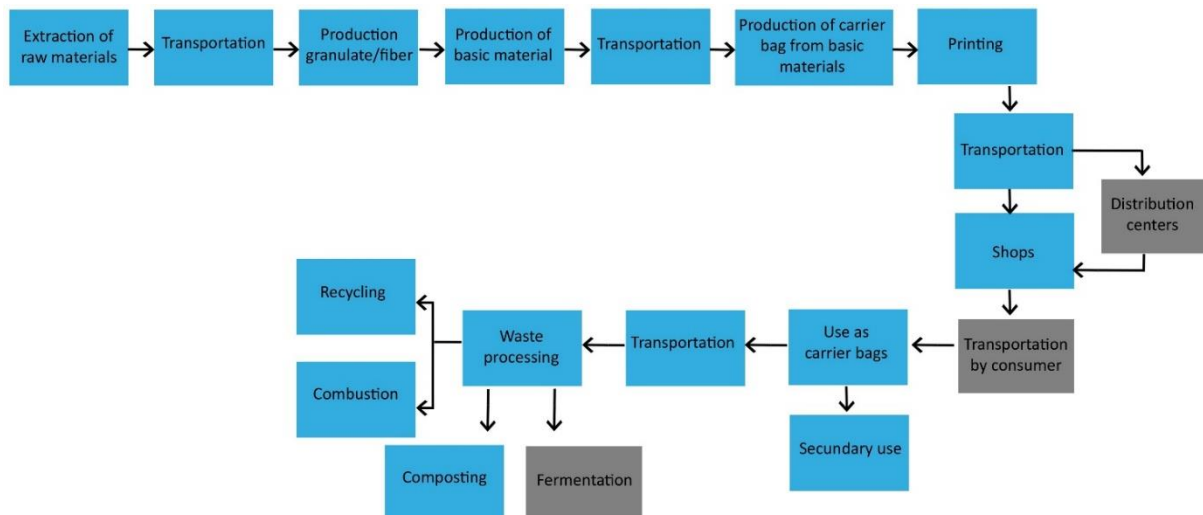


Figure 6: System boundaries from Boukris et al. (2015). The blue boxes are taken into account in their LCA study. Grey is not taken into consideration. Translated and adjusted from Boukris et al. (2015).

While Boukris et al. (2015) looked in their research at the national level, this study focuses on the city of Utrecht. Therefore, the waste management streams as reported by Boukris et al. (2015) were compared to the waste streams in Utrecht as reported in Hoek (2019), and the processing of waste as reported in CBS (2019). Similar waste streams were found.

3.5.3 Impact assessment methods

In an LCA study, multiple life cycle impact categories are included. This is done in order to avoid shifting the burdens from one impact category to another (Flanigan, Frischknecht & Montalbo, 2013). The following impact categories were chosen to include in this study:

- Climate change
- Ozone depletion
- Terrestrial acidification
- Freshwater eutrophication
- Marine eutrophication
- Human toxicity
- Terrestrial ecotoxicity
- Agricultural land occupation
- Urban land occupation
- Water depletion

This selection was based on data available from the study performed by Boukris et al. (2015), and due to the importance of these impact categories in policy decisions (Sala, Reale, Cristobal-Garcia, Marelli & Pant, 2016).

Boukris et al. (2015) did not investigate the PP non-woven bag in their research. However, this type of bag had to be included in the survey since it was offered in every store type (Section 4.1). Bisinella et al. (2018) considered both PP woven and PP non-woven bags in an LCA study. In their report, the authors state that the manufacturing materials and energy requirements are similar for the PP woven and the PP non-woven. The only difference between the bags was their weight (118.7g for PP woven

bags and 137g for PP non-woven bags). The PP non-woven is 1.15 times heavier than the PP woven. When comparing the results of the LCA study of the two bags, all impact categories considered in their study had a factor between 1.11 and 1.18. Therefore, it was decided to model the impacts of the PP non-woven bag by multiplying the factor of 1.15 to the impacts of PP woven bags.

3.5.4 Comparing the environmental impact of different scenarios

To compare the environmental impact of different scenarios, the outcomes of each scenario were also expressed in shadow costs. These shadow costs are used to weigh different impact categories so that they have only one indicator. This indicator was the costs necessary to compensate for the impact category (De Bruyn et al., 2010). The shadow costs used for this comparison were the same as in the study of Boukris et al. (2015) and are shown in Appendix C: Shadow costs, as well as the shadow costs for the different bags (Appendix D: Shadow costs of different bags). These results show that when the environmental impact of the different bags are expressed in shadow costs the HDPE bags has the lowest shadow costs and the cotton bag the highest.

3.5.5 Littering potential

At the moment, LCA methodology is not able to provide information on the environmental impacts of littering, even though littering is one of the biggest impacts of plastic carrier bags (as explained in the Introduction). Civancik-Uslu, Puig, Hauschild and Fullana-i-Palmer (2019) introduced a littering indicator that enabled to compare the littering impact of different type of bags. In this indicator, no absolute impacts are estimated, but the relative risk of bags to end up as litter into the environment is compared. The assessment is based on four parameters:

- P1 - Quantity of residual bags. What is the number of bags required to comply with the functional unit of the LCA and the surface size of these bags.
- P2 – Environmental release. This represents the chance of the bag to end up in the environment. The price of the bag was taken as a strong contributor.
- P3 – Environmental dispersion. For this, the floatability of the bags is taken as a parameter. The weight of the bags is taken as the defining measure.
- P4 – Environmental persistence. This represents the time for how long the bag will remain in the environment after ending up there. The biodegradability of the material is taken as the defining measure.

This littering potential index was defined by the following equation

$$LP = \frac{P1^{f1}}{P2^{f2} \times P3^{f3} \times P4^{f4}}$$

In this equation f1, f2, f3 and f4 are weighting factors. Currently these weighting factors are all set to a value 1, until further research shows that it should be a different value. The parameters P1, P2, P3 and P4 are calculated with the following equations.

$$P1 = \frac{(n \times S)}{(n \times S)_{max}}, P2 = \frac{P}{P_{max}}, P3 = \frac{w}{w_{max}} \text{ and } P4 = \frac{d}{d_{max}}$$

Where

- n = number of bags
- S = Surface area of one side of the bag (m²)
- $(n \times S)_{\max}$ = Maximum result among the bags
- P = Price of the bag (Euro)
- P_{\max} = Maximum price among the bags
- w = Weigh of the bag (g)
- w_{\max} = Maximum weight among the bags (g)
- d = Environmental degradation rate of the material used in the bag (1/day)
- d_{\max} = Maximum environmental degradation rate among the bags (1/day)

In this study, the number of bags was set at 1, since only the purchase of bags is compared³. The price of the bags is based on the field research (Section 3.1) and the weight of the bags was taken from Boukris et al. (2015). The surface area of the bags and the environmental degradation rate were not exactly known. Therefore, different sizes and degradation rates were used for the calculation to see the effect of different values. First a ranking was used for the bags, to sort the bags from the smallest size (1) to the biggest size (3) (only three sizes were used, explained in Section 4.1) and from the least degradable (1) to the most degradable (3). The estimates of the surface of the bags were based on the values used by Civancik-Uslu et al. (2019) and on the number of bags used for different weight of grocery purchased in Boukris et al. (2015). The degradation rates of the bags were also based on the values used in Civancik-Uslu et al. (2019) and on the degradation time of different materials as they are stated in Islam, Saha, Bakr and Mondal (2015). In Table 6, the values used for the calculation of the littering potential can be found. The different values used for the surface area (3) and degradation rates (5) are shown as well. In total, 15 different combinations were calculated (A to O).

³ With the formula determined by Civancik-Uslu et al. (2019) only a ranking of the different types of bags can be determined for a set functional unit. For example, the functional unit used in the study by Civancik-Uslu et al. (2019) was “*To facilitate the transportation of purchased food and drinks to an average household for one year, from the point of sale to the place of consumption*”. For each bag type the number of bags required to fulfil this functional unit was determined (e.g. 408 HDPE bags and 41 LDPE bags). In this study, bags individually do not fulfill the functional unit. However, scenarios with varying combinations of bags correspond to the functional unit. Therefore, the number of bags (n) used in the formula by Civancik-Uslu et al. (2019) was set at 1 for all bags, because then the purchase of the different carrier bags is compared.

Table 6: Values used for the calculation of the littering potential. In total 15 combination were calculated.

	HDPE bag	LDPE bag	Paper bag	PP non-woven	PP woven	PET bag	Jute bag	Cotton bag
P1								
s (m ²)	1	2	2	3	3	2	2	2
Ranking								
s (m ²)	0.1	0.21	0.21	0.25	0.25	0.21	0.21	0.21
s (m ²)	0.1	0.21	0.21	0.3	0.3	0.21	0.21	0.21
P2								
p (Euro)	0.06	0.19	0.18	1.04	1.55	1.79	2.36	3.43
P3								
w (g)	6	30	57	149.5	130	32	150	78
P4								
d (1/day)	1	1	3	1	1	1	2	2
Ranking								
d (1/day)	1	1	2	1	1	1	3	3
Ranking								
d (1/day)	0.1	0.1	13.6	0.1	0.1	0.1	13.6	13.6
d (1/day)	0.1	0.1	13.6	0.1	0.1	0.1	1	1
d (1/day)	0.1	0.1	13.6	0.1	0.1	0.1	19	19

3.5.6 Comparing littering potential in different scenario situations

The littering potential proposed by Civancik-Uslu et al. (2019) can only be used for comparison purposes, and no absolute value for a littering potential is given. In order to be able to use this value to calculate a total littering potential per scenario, the ranking obtained from the littering potential calculation was further converted into a weight factor. This weight factor was applied to each bag type. Each bag was given a value between 0 and 1, depending on the ranking of the bag. To compare the different scenario situations, the number of bags purchased in each scenario was multiplied with this value. These relative numbers can be helpful to gain a deeper understanding how different scenarios rank. However, it is important to keep in mind that the calculated values are for comparing purposes only, and no absolute value is given.

4. Results

In the next sections the results are shown of the following steps. First, the results of the field research are shown in Section 4.1, which determines the store types and bag types considered in this study. Next, the responses of the survey are elaborated on in Section 4.2, including the statistical tests. In Section 4.3, the results are shown of the calculation of the number of bags purchased in the city of Utrecht. Lastly in Section 4.4 these results are expressed in an environmental impact.

4.1 Field research

By carrying out the field research the selection was made of which store types and bag types were included for this study.

Store types

An adjusted⁴ list of stores from the website *Indebuurt* (2019) and *Bezoek-Utrecht* (2019) can be found in Appendix E: List of stores in the city of Utrecht. This list is structured from most stores of a certain type to least. The table shows that the most prevalent store type is the grocery store (262 stores) according to *Indebuurt* (2019). These grocery stores include supermarkets (78 stores) and food-retail stores (184 stores) (e.g. bakers, greengrocers or butchers). However, the image in the city centre is slightly different, "*Bezoek-Utrecht*" (2019) lists the clothing store as the most abundant in the city centre.

Lastly, the table shows that a lot of non-food stores are present such as department stores. It was decided that shops that sell different types of items are included in the category department store. This means that stores such as HEMA and Action are included in this store type.

Summarizing this means that the following four store types are selected for the rest of this study:

- Supermarkets
- Food-retail stores
- Clothing stores
- Department stores

Bag types

At least ten stores were visited of each store type to determine which bags and for which price they offered them. The data of the stores were collected on the 12th and 13th of September 2019. More detailed results of the field research can be found in Appendix F: Extensive table of field research.

⁴ Some restaurants, hotels, banks etc. appeared in this list. These were eliminated since they are out of the scope of this study.

Table 7: Results of the field research. The table shows the number of stores visited per store type and in how many of those store a certain type of bag is offered. When a number is between brackets, this means how often a bag is offered for free. E.g. 4 (1) means the bag is offered 4 times of which 1 is offered free of charge.

	Supermarket	Food-retail	Clothing store	Department store
Number of stores visited	10	11	22	10
HDPE bag	2	3 (1)	0	2
LDPE bag	7	7	7 (1)	3
Paper bags	3	6 (4)	16 (14)	6 (4)
Non-woven PP	1	1	2 (1)	2
Woven PP	8	0	3	5
PET bag	1	0	1	2
Textile bag; Jute	2	0	0	0
Textile bag; Cotton	2	1	4 (1)	2

Table 7 shows how prevalent certain bag types are per store type.

In supermarkets, thicker plastic bags and plastic shoppers are offered the most. Food retailers mainly offers thicker plastic bags and paper bags. Clothing and department stores mainly offer paper bags. These paper bags are mostly offered for free. Not all bags listed in Section 2.4.2 are offered in the stores included in this research. For example, biodegradable bags were never offered. Therefore, only the bags that were found in the field research (Table 7) were considered in this study. Next to this, some stores offered bags in different sizes (Appendix F: Extensive table of field research). Since the results of this study are based on survey results, it was decided to take an average bag size to keep the survey questions more general.

Bag size and price

In Table 8 the average size and the highest, lowest and average price of the different bag types are shown. The bag sizes are categorized the same way as in Boukris et al (2015).

Table 8: Characteristics of bags used in the study.

Bag type	Average size	Lowest price	Highest price	Average price
HDPE bag	Small ⁵	€ 0.03	€ 0.10	€ 0.06
LDPE bag	Medium	€ 0.05	€ 0.49	€ 0.19
Paper bags	Medium	€ 0.05	€ 0.50	€ 0.18
PP non-woven	Big shopper	€ 0.50	€ 2.50	€ 1.04
PP woven	Big shopper	€ 0.58	€ 2.99	€ 1.55
PET bag	Medium	€ 1.49	€ 1.99	€ 1.79
Textile bag; Jute	Medium	€ 1.50	€ 1.95	€ 2.36
Textile bag; Cotton	Medium	€ 1.00	€ 6.99	€ 3.43

There were also foldable bags offered with a price of €11.95 and €9.95 and a cotton bag of €8.95 but these bags had a print of a painting on it and sold as a collector's item. Therefore, these bags were not included in the calculation of the average prices of the bags. The thin plastic bag is the cheapest and a

⁵ Original name in Boukris et al (2015): "Hemdtas".

cotton bag the most expensive. The rounded number of the average price is used in the survey questions. Table 9 shows the different bag types allowed in each policy scenario (as considered in Section 1.5) and how these bags are referred to in the survey. For the different scenarios, certain bag types are excluded.

Table 9: Overview of the bags in the different scenarios. Names and prices as used in the survey are shown.

	Current situation	Scenario 1	Scenario 2	Scenario 3
High-density polyethylene (HDPE) bags	Thin plastic bag (€ 0.05)			
Low-density polyethylene (LDPE) bags	Thicker plastic bag (€ 0.20)			
Paper bag	Paper bag (Free of charge)	Paper bag (Free of charge)	Paper bag (€ 0.20)	
Polypropylene (PP) non-woven bag	Fabric shopper (€ 1.00)	Fabric shopper (€ 1.00)	Fabric shopper (€ 1.00)	Fabric shopper (€ 1.00)
Polypropylene (PP) Woven bag	Plastic shopper (€ 1.60)	Plastic shopper (€ 1.60)	Plastic shopper (€ 1.60)	Plastic shopper (€ 1.60)
Polyester (PET) bag	Foldable bag (€ 1.80)	Foldable bag (€ 1.80)	Foldable bag (€ 1.80)	Foldable bag (€ 1.80)
Textile bag; Jute	Jute bag (€ 2.40)	Jute bag (€ 2.40)	Jute bag (€ 2.40)	Jute bag (€ 2.40)
Textile bag; Cotton	Cotton bag (€ 3.40)	Cotton bag (€ 3.40)	Cotton bag (€ 3.40)	Cotton bag (€ 3.40)

4.2 Survey

In total, 453 surveys were completed in the period between 16th October 2019 and 4th November 2019. 15 of the completed surveys were not considered because these respondents answered “No” to the questions whether they lived in a city, Utrecht or if they ever went shopping in Utrecht. Therefore, 437 surveys will be used for the analysis, of which 84 surveys were filled in on paper and 353 were filled in online. With this number of participants, the sampling error of the survey is minimized to stay within a 5% confidence interval of a confidence level of 95% (De Leeuw, Hox & Dillman, 2012). The survey was completed 380 times in Dutch and 57 times in English. The youngest respondent was 15 years old, and the oldest respondent was 86 years old. An overview of the demographic profile of the survey participants can be found in Figure 7. Of the respondents, 70.0% were female, and the majority of respondents were in the age categories 15-25 (28.8%) and 26-35 (28.4%). An extensive table with the respondents’ demographic information can be found in Appendix H: Extensive table survey respondents. Adjustments and assumption made to the survey responses can be found in Appendix I: Survey respondent adjustments. Results from the statistical tests performed on part of the survey questions can be found in Appendix G: Statistical tests. The statistical test results of selected questions are discussed in the sections below. Exemplary quotes of survey respondents are included in the following discussion. Statements given in Dutch have been translated into English, the original quotes are provided in the footnotes.

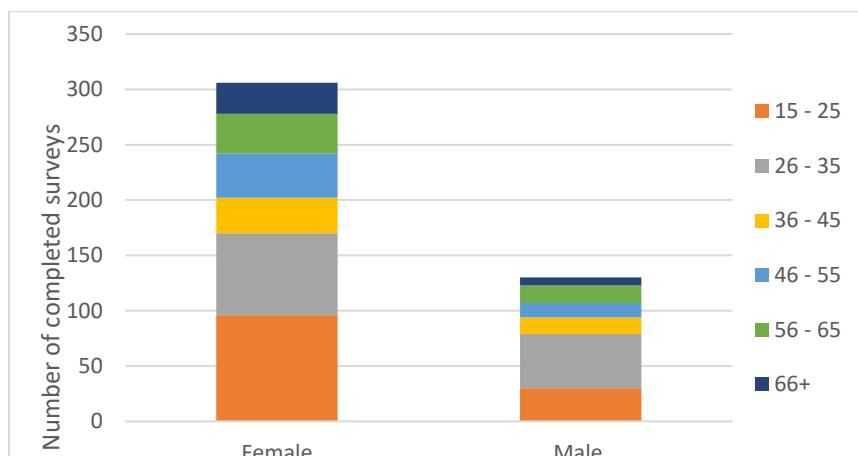


Figure 7: Survey's respondents socio-demographic characteristics.

Figure 8 summarises the survey results for questions 7 and 8. The results indicated that most of the respondents have a plastic shopper⁶ (79% of respondents), followed by thicker plastic bag (75%), while the least frequent bag was a jute bag (28%). The types of stores where respondents acquired bags most often were supermarkets and clothing stores. Only 8 of the respondents said that they did not own any kind of carrier bag intended for multiple use.

⁶ In the results of the survey, the different bag types are named as they were in the survey. The list of the different names is stated in Section 4.1.

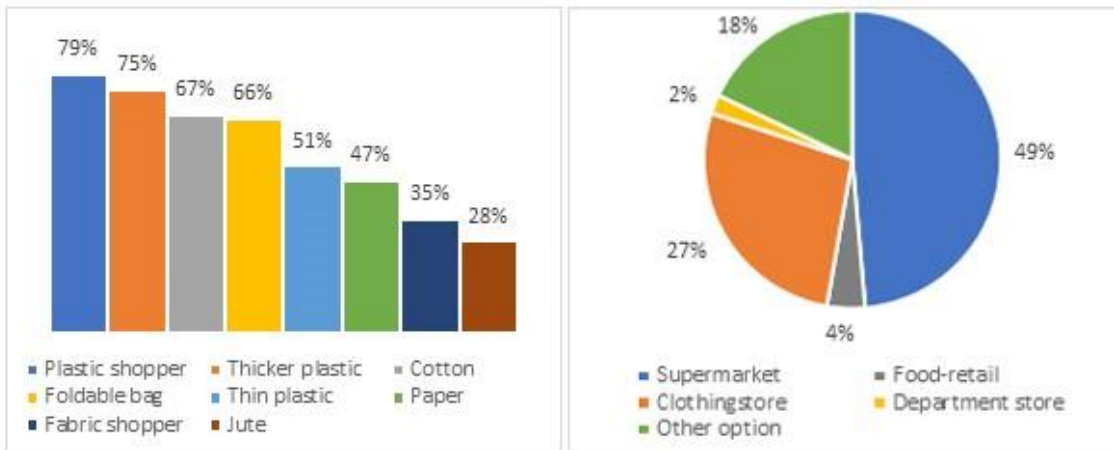


Figure 8: Q7. Which bag do you have at home? (Left) and Q8. In which store do you get or buy a bag most often? (right)

Q9. Since 2016 it is not allowed to distribute plastic bags free of charge. Do you feel that the introduction of a tax on single-use plastic carrier bags has made you more aware of your current plastic consumption?

Eighty-one percent (356) of respondents said that the introduction of a tax on single-use plastic carrier bags has made them more aware of their plastic consumption (*“Even though the penalty for forgetting a bag and thus having to buy one is very small, it does make you aware of your mistake. I often times put some effort into finding a way to bring the groceries back without having to buy a bag, when I could've easily payed for one.”*, *“Bought an extra bag too easily; now no more”*⁷, *“I always carry one or two foldable bags with me”*⁸ or *“You know that bags aren't free anymore.”*⁹).

However, 48 respondents said that the ban did not have an influence on their perception, since they were already aware of the problem potential of plastic bags (*“Don't buy a bag, I already think it's foolish for years.”*¹⁰, *“I was already aware of the problems associated with plastic”*, *“I already have a foldable bag standard in my purse for years, so not much had changed for me”*¹¹, *“I'm aware regardless”*, or *“Tried to avoid plastic bags already”*¹²). Eleven respondents said that it did not make them more aware since the tax on bags was too low, or they just needed the bags (*“Because prices of these plastic bags remain so low, for many it doesn't make a huge difference.”*, *“Always forget them and 10 cents is no problem”*¹³, *“I just need a bag. I don't always have a bag with me.”*¹⁴ or *“The thicker plastic supermarket bag cost money anyway, and if I need a bag in another shop I'm happy to pay. After all, I need it.”*¹⁵).

⁷ “Kocht te makkelijk een extra tas; nu niet meer”

⁸ “Ik heb nu altijd één of twee opvouwbare tassen bij me”

⁹ “Je weet dat tassen niet meer gratis zijn”

¹⁰ “Koop geen tas. Vind het al jaren van de zotten.”

¹¹ “Ik heb al jaren een opvouwtasje standard in mijn tas zitten, dus voor mij veranderde er niet veel”

¹² “Probeerde plastic tassen al te vermijden”

¹³ “Vergeet ze steeds en 10 cent is geen probleem”

¹⁴ “Tasje heb ik gewoon nodig. Ik heb er niet altijd een opzak”

¹⁵ “De dikker plastic supermarkt tas kostte sowieso al geld, en als ik nu een in een andere winkel een tas nodig heb betaal ik graag. Ik heb m tenslotte nodig.”

Q10. What do you do with your plastic carrier bags (thin and thicker) after using them?

The great majority of respondents stated that they reuse plastic carrier bags again as carrier bags (87%, Figure 9). Next to this, 60% (263) of the respondents said that they reuse the plastic bags as garbage bags. Only 5% (23) said that the plastic carrier bags are disposed with the general waste and 29% (125) said they dispose the carrier bags in the plastic container. Out of the 12% (51) of respondents who chose "Other option", some respondents (12) indicated that they use bags for collecting garbage ("I use it to bring glass to the glass container, then I dispose it with the plastic waste."¹⁶, "I usually use them as a bag to collect my plastic waste, then put everything in the plastic bins", "I put old newspapers in it, these are collected by a school"¹⁷, or "Transport leaking old glass. Waterproof protect contents linen bag."¹⁸). Five times it was mentioned that plastic bags are used to keep items dry from rain ("Re-use as rain protection for my backpack"¹⁹ or "As a saddle cover when my saddle is wet ;) But with a little shame. Plastic shouldn't be used anymore."²⁰).

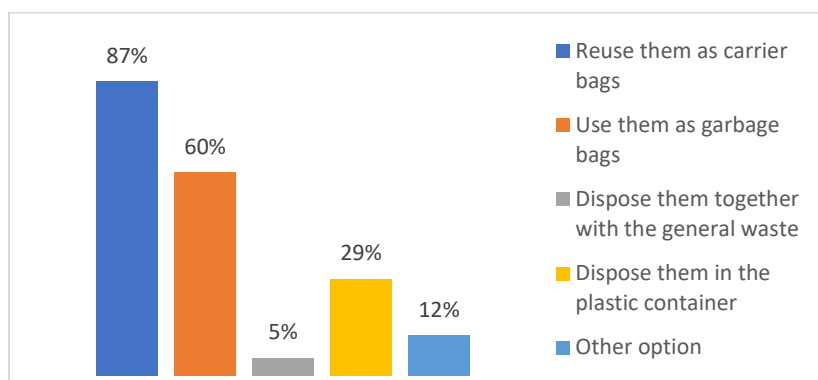


Figure 9: What do you do with your plastic (thin and thicker) carrier bags after using them?

Q11. If you reuse a bag, how often do you reuse the bags before disposing them? (Write in each box an approximate amount of times.)

In question 11, respondents were asked to estimate the amount of times they could reuse a certain type of bag. Table 10 displays the lowest and highest given number, the mean and the median per type of bag, respectively. Column "n" states the number of respondents who filled in a value for the different categories. Looking at each category, the differences between the mean value and the median value are fairly big. More extreme answers had a major distorting impact on the mean value. For example, the highest given value for reusing the plastic shopper was 100,000 which led to a mean value of 630.0. When this answer was excluded, the highest value was 1000, which led to a mean value of 109.7 times reuse. It was also noted that a lot of the respondents gave indications for the times of reuse such as "Often"²¹, "Approximately once a week"²², "4 times a week"²³, "Infinite"²⁴ "Until broken"

¹⁶ "Gebruik om glas naar glasbak te brengen en daarna bij plastic afval"

¹⁷ "Stop er oude kranten in die worden door een school opgehaald"

¹⁸ "Lekkend oud glaswerk vervoeren. Waterdicht beschermen inhoud linnen tas"

¹⁹ "Hergebruik als bescherming tegen de regen voor mijn rugzak"

²⁰ "Als zadelhoes als mijn zadel nat is ;) Maar wel met lichte schaamte. Plastic kan echt niet meer."

²¹ "vaak"

²² "Ongeveer 1 keer per week"

²³ "4x per week"

²⁴ "Oneindig"

or “Quite often, although not much fits in”²⁵. These answers were not considered in the calculation of the mean and median value.

Table 10: Q11. If you reuse a bag, how often do you reuse the bags before disposing them? The table shows how often an estimate was filled in (n), the lowest, highest, mean and median value. Next to this, the impact is shown of the highest value filled in.

	n	Lowest	Highest	Mean	Median
Thin plastic	251	0	50	3.0	1
Thicker plastic	236	0	2009	51.8	10
	235	0	1000	43.4	10
	231	0	500	26.9	10
Paper	179	0	30	2.3	1
Fabric shopper	66	0	1000	98.1	50
	65	0	500	84.2	50
Plastic shopper	192	0	100000	630.0	50
	191	0	1000	109.7	50
Foldable bag	136	0	1000	158.8	100
Jute	64	0	1000	127.2	90
Cotton	142	1	10000	413.8	100
	139	1	1500	206.9	100

Q12. How often do you go to the following stores? (Give your answer in approximate times a month)

Table 11 shows the lowest, highest, mean and median value of the answers to question 12. Respondents go most frequently to supermarkets with an average of 13.3 times a month. For supermarkets, clothing stores and department stores, the mean values show a statistically significant difference between men and women. Male respondents go to supermarkets more often than female respondents, while female respondents visit clothing stores and department stores more often.

Table 11: Q12. How often do you go to the following stores? (Give your answer in approximate times a month). The table shows the lowest, highest, mean and median value filled in. This is shown for all respondents, and for the male and female respondents separately. When a value is shown in bold, this means that there is a statistically significant difference between the answer given by male and female respondents.

		Lowest	Highest	Mean	Median
Supermarket	All (437)	1	60	13.3	10
	Male (130)	2	60	15.1	12.5
	Female (306)	1	35	12.5	10
Food-retail	All	0	24	3.3	2
	Male	0	20	3.8	3
	Female	0	24	3.1	2
Clothing store	All	0	15	1.6	1
	Male	0	15	1.2	1
	Female	0	15	1.7	1
Department store	All	0	20	2.3	2
	Male	0	10	1.7	1
	Female	0	20	2.5	2

²⁵ “vrij vaak, al past er wat weinig in”

The mean of the food-retail and department store also showed a statistically significant difference when the age categories of the respondents were compared, these results are shown in Table 12. Respondents in the higher age categories report to go more often to a food retail than respondents in lower age categories. For department stores, the answers are more evenly distributed, with the lowest age category visiting department stores most often.

Table 12: Q12. How often do you go to the following stores? In this table the different age categories are compared. The mean and median values are shown for the food-retail and department store.

		15 -25	26 - 35	36 - 45	46 - 55	56 - 65	66+
Food-Retail	Mean	1.83	2.64	4.43	4.73	4.82	5.09
	Median	1.0	2.0	4.0	4.0	4.5	4.0
Department store	Mean	2.68	2.33	1.77	2.50	1.82	2.06
	Median	2.0	2.0	2.0	2.0	1.0	2.0

Q13. When you got to the following stores, which type of bag do you usually use or buy?

Figure 10 shows the general use of carrier bags as filled in by the respondents in the current situation. In this question respondents were unable to choose a paper bag for the supermarket. For all types of store, the majority of respondents said that they bring their own bag. Respondents said they bring a bag the least to a clothing store, in which case they choose most often a free paper bag as alternative.

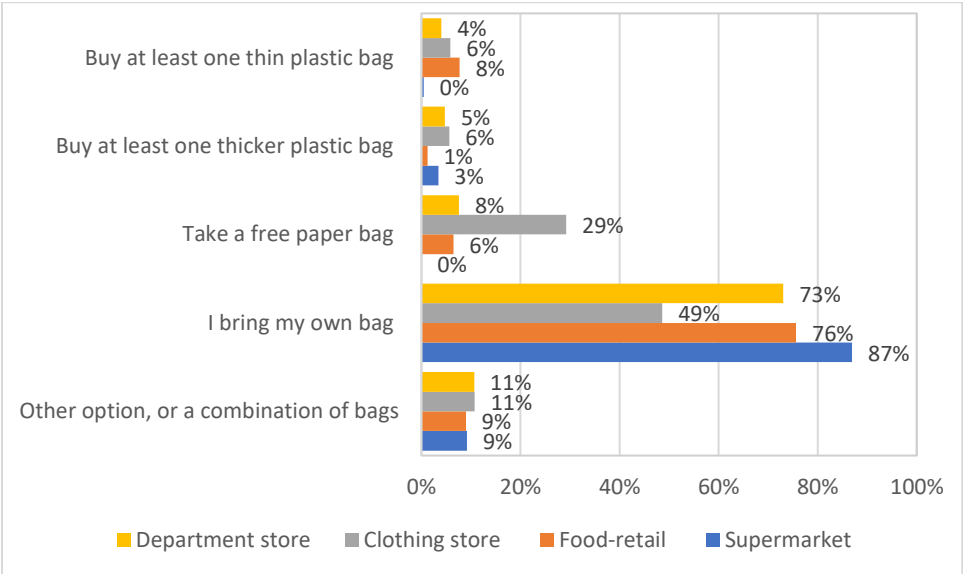


Figure 10: Q13. When you go to the following stores, which types of bag do you usually use or buy?

A statistically significant difference is visible between males and females in the options they choose for supermarkets, clothing stores and department stores. In a supermarket, men buy a plastic bag more often than women (male 5%, female 3%). In a clothing store, women choose more often to bring their own bag (55% female, 33 % male), while men buy a plastic bag more often (for thin plastic bags: male 9%, female 4%; for thicker plastic bags: male 11%, female 3%). The same holds for the department store: females bring their own bag more often (77% female, 64% male), while male buy or take a new bag more often (free paper bag: 10% male, 6% female; thicker plastic bag: 10% male, 2% female).

Q14. How many of the bags chosen in the previous question do you need each time that you go to these stores?

In Table 13 the mean and median for question 14 can be found. Only for the supermarket respondents use more carrier bags than for the other store types. Statistical tests show no difference between males and females, different age categories or level of education.

Table 13: Q14. How many of the bags chosen in the previous question do you need each time that you go to these stores? Mean and median values are shown.

	Mean	Median
Supermarket	1.75	1.5
Food-retail	1.04	1
Clothing store	1.08	1
Department store	1.01	1

Q15. If you chose to bring your own bag which type of bag do you usually use?

In question 15, most of the options mentioned by the respondents were similar to the options that were given later in the survey (thicker plastic, fabric shopper, plastic shopper, foldable bag, jute and cotton). Furthermore, a backpack or handbag was often mentioned. Also, bicycle panniers were mentioned multiple times.

Q16. If you chose another option or a combination of bags, could you specify what is it?

A variety of answers was given for questions 16. Respondents explained the alternatives they use, such as “backpack”, “A backpack, often supplemented with a jute or plastic shopper or thicker plastic bag”²⁶, “Shopping cart”²⁷ or “Crate in the car for the supermarket”²⁸. People also explained situations in which they do receive or buy a bag: “In clothing stores you often still get a bag. In addition, you quickly use a small plastic bag in supermarkets for fruit and vegetables”²⁹, “Depends on what kind of vegetable or fruit it is. If it is not in a bag, asking for a bag is useful, otherwise your own bag”³⁰ or “If I don't have enough space in the bag I brought with me, I'll buy the smallest possible bag to take everything with me. This doesn't happen often but it does happen monthly. Mainly in the supermarket or during unplanned shopping sessions in the city centre.”³¹.

Q17. How often do you forget to bring your own bag to a store? (Choose 1 option per store)

For supermarkets, significant differences between all socio-demographic characteristic (gender, age and level of education) were observable in question 17. For all other stores, only gender showed a significant difference in how often respondents forget to bring their own bag.

²⁶ “Een rugzak, vaak aangevuld met een jute of plastic shopper of dikkere plastic zak”

²⁷ “Boodschappenwagentje”

²⁸ “Kratje in de auto voor de supermarkt”

²⁹ “In kledingwinkels krijg je alsnog vaak een tas mee. Daarnaast gebruik je in supermarkten snel een klein plastic tasje voor de groente en fruit”

³⁰ “Hangt er vanaf wat voor groente, fruit het is, als het niet in een zakje zit is een tasje vragen handig, anders een eigen tas”

³¹ “Als ik niet voldoende ruimte heb aan de tas die ik meegenomen heb, koop ik het kleinst mogelijke tasje om alsnog alles mee te nemen. Dit komt niet vaak, maar wel maandelijks, voor. Voornamelijk in de supermarkt of bij ongeplande shopsessies in de binnenstad”

In Figure 11 the results from all respondents, male respondents and female respondents are shown. When the different stores are compared, it can be observed that the respondents forget more often to bring bags to clothing stores. For clothing stores, 33% of the respondents said that they forget to bring their own bag half of the time or even more often. The option “I never bring my own bag” is the most often chosen for clothing stores (11% of all respondents, 19% of all male respondents, 8% of all female respondents).

Respondents were least likely to forget to bring their own bag to the supermarket. 56% of all respondents said that they never forget to bring their own bag and 35% said that they forget to bring their bag less than half of the time. For all store types, female respondents answered more often that they never forget to bring their own bag than male respondents. This difference is the biggest for the department store, in which case 44% of female respondents state that they never forget to bring their own bag compared to 25% of male respondents.

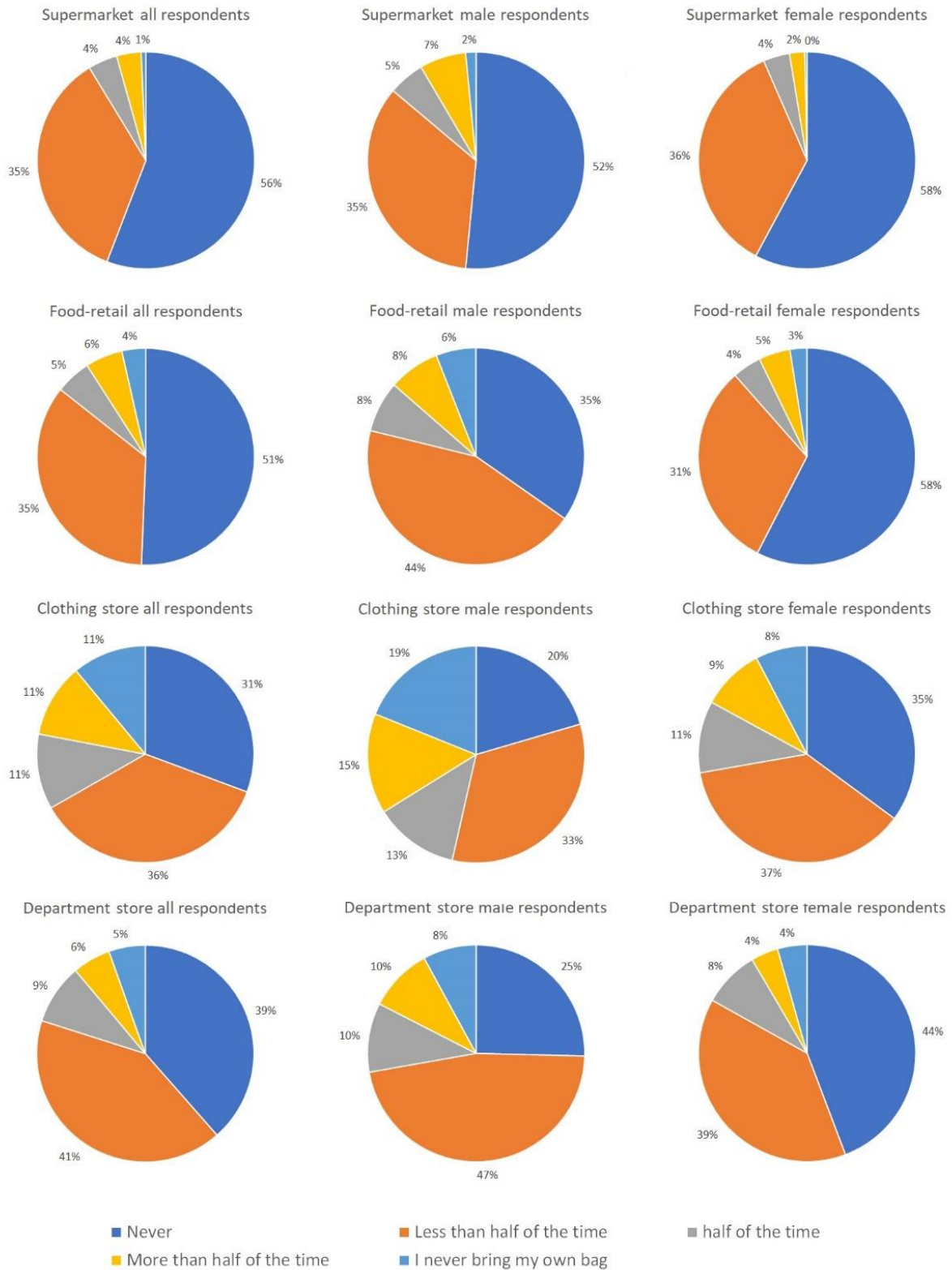


Figure 11: Q17. How often do you forget to bring your own bag to a store? This is shown for all respondents, and for the male and female respondents separately.

Figure 12 shows the responses of the different age categories for the supermarket. The higher age categories were most likely to choose the options “Never” and “Half of the time”, while responses in lower age categories were divided more evenly among options.

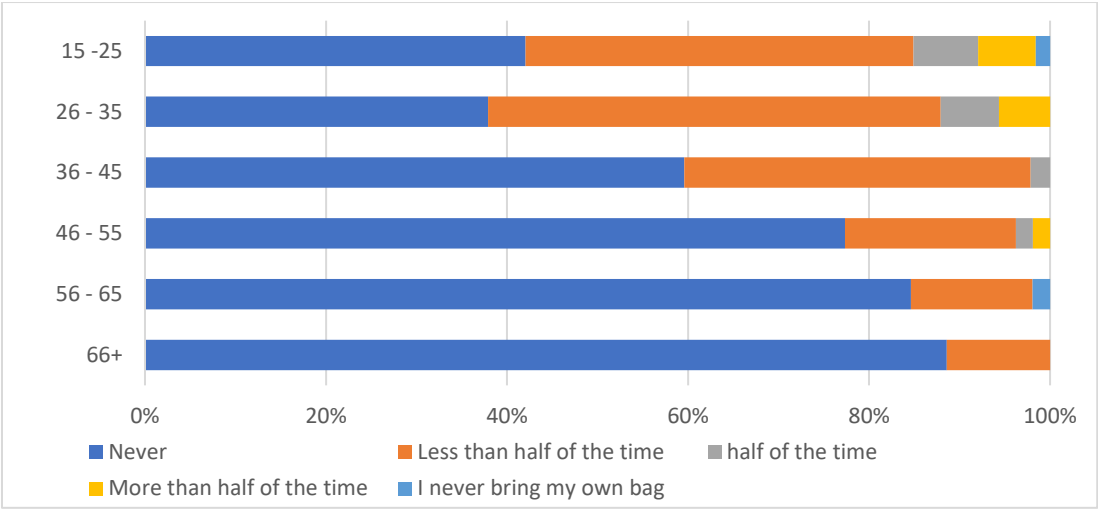


Figure 12: Q17. How often do you forget to bring your own bag to a Supermarket? Different age categories.

Q18. If you forget to bring your own bag, which option would you choose?

In Figure 13 the results from question 18 are shown. In the supermarket, the most chosen bag is the thicker plastic (46%) followed by the thin plastic bag (22%) and other options (17%). For food-retail, clothing stores and department stores, the most chosen option is a paper bag (which is the only free option). For food-retail, thin plastic was the second most chosen option while for clothing stores and department stores, thicker plastic came in second place.

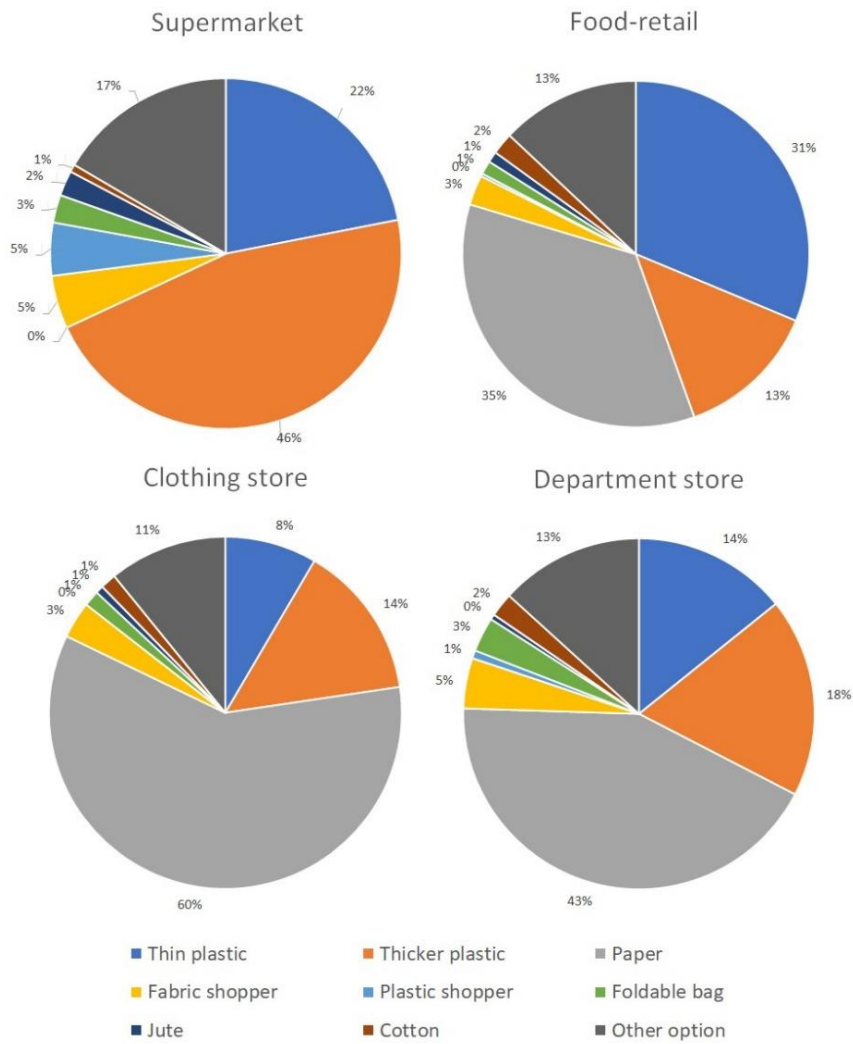


Figure 13: Q18. If you forget to bring your own bag which option would you choose? Different store types.

For the supermarket a statistically significant difference could be found between the age categories. The results are shown in Figure 14. From the age category 46 – 56, plastic bags (thin plastic and thicker plastic) were chosen less frequently. In the highest age category (66+), the option foldable bag was chosen more frequently (15%) than in other age categories.

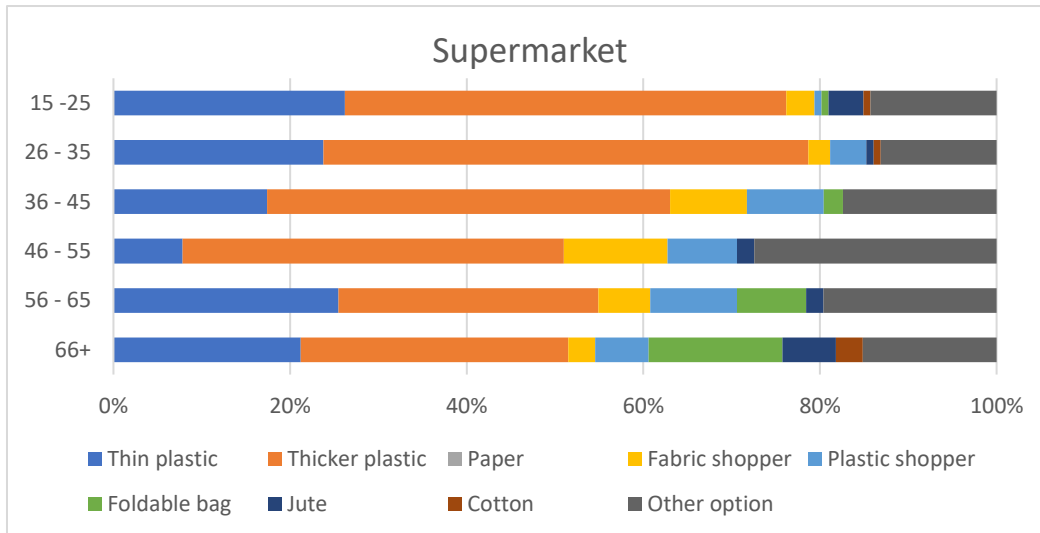


Figure 14: Q18. If you forget to bring your own bag, which option would you choose? Supermarket for the different age categories.

In addition, a significant difference was found between males and females in the bags they chose for the department store. As represented in Figure 15, both male and female respondents chose “Paper” most often, but the share of female respondents is higher than of male respondents (48% compared to 30%). When thin and thicker plastic bags are combined into one category of bags, a plastic bag is chosen most often by male respondents (48% combined), while for women the paper bag stays the preferred option (26% combined).

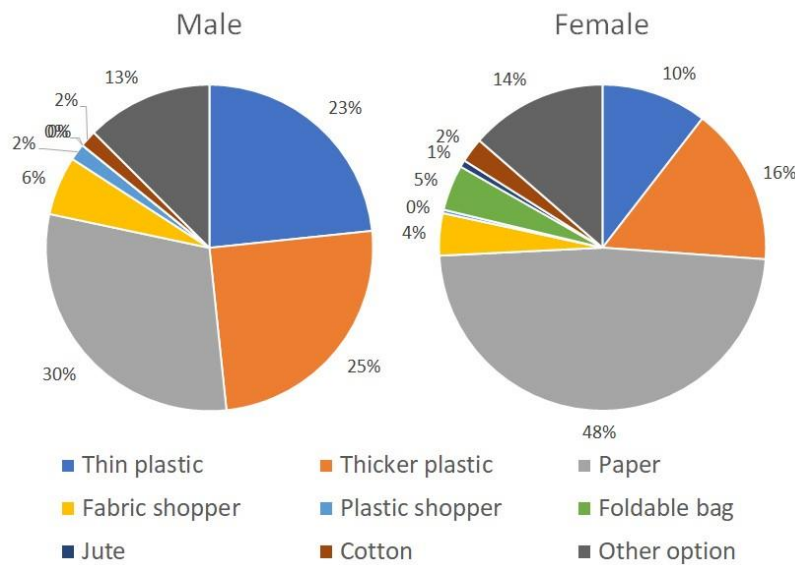


Figure 15: Q18. If you forget to bring your own bag, which option would you choose? Males and females compared for the department store.

Q19. If you chose "other option", could you specify what it is?

Very diverse answers were given to question 19. Some respondents explained why it is unlikely that they forget to bring their own bag (*"It's never an option to go shopping in a supermarket without bag, if I don't have bag the means I go shopping for something small that can fit in a pocket."*, *"I never forget my bag"*, *"I never buy bags, but I do put fruit and vegetables (if I forgot my bags) in the supplied plastic bags or if it is not too much I just carry it in my hands."*³² or *"Because my foldable bag is always in my bag I always have it with me"*³³).

Others described the alternative option they would choose such as: *"No bag. I put everything loose in my bicycle bag."*³⁴, *"I will look for a cardboard box in the supermarket, or I will go back home to pick up a bag."*³⁵, *"Supermarket allows to take a cardboard box."* or *"I'll take the shopping cart to my bike or car and put the items loose in the back seat"*³⁶.

Some respondents also answered: *"I'll take the bags for the fruits and vegetables"*³⁷, *"I hope to get a cotton bag"*³⁸, or *"I always buy clothes with friends and use their bags and always buy small amounts of food which I can almost always carry"*. Others explained how they would carry bought items home without a bag: *"I will do my best to carry the items loosely"*, *"I don't take a bag and I'll mess around with the bought items..."*³⁹ or *"I try to pack stuff in my pockets and carry it even though I might drop stuff"*.

³² *"Ik koop nooit tasjes, wel doe ik groente en fruit (als ik tasjes ben vergeten) in de bijgeleverde plastic tasjes óf als het niet te veel is draag ik het gewoon in m'n handen"*

³³ *"omdat mijn vouw tas altijd in mijn tas zit heb ik het altijd bij me"*

³⁴ *"Geen tas. Ik gooi alles los in mijn fietstas."*

³⁵ *"Ik zoek een kartonnen doos in de supermarkt, of ik ga terug naar huis om een tas op te halen."*

³⁶ *"Ik rij de kar naar mijn fiets of auto en leg de spullen los in de achterbank"*

³⁷ *"Ik pak de groente en fruit zakjes"*

³⁸ *"Ik krijg hopelijk een katoenen tas"*

³⁹ *"Ik neem geen tas en ga lopen klooiën met mijn gekochte spullen..."*

Q34. Do you think that a ban on plastic bags in Utrecht is a good idea? (Choose 1 option)

In Figure 16 the results from Q34 can be found. Overall, the survey respondents were positive about the idea of implementing a ban on plastic carrier bags. In total, 67% of the participants think that a ban is a very good idea and 21% think it is a good idea. Also, 7% of the participants were neutral about the idea of a ban on plastic bags and 4% were negative about the idea. Female respondents were more positive about the idea than male respondents (92% of female respondent, 82% of male respondents), while a bigger part of the male respondents were neutral about the idea (12% of male respondents, 5% of female respondents).

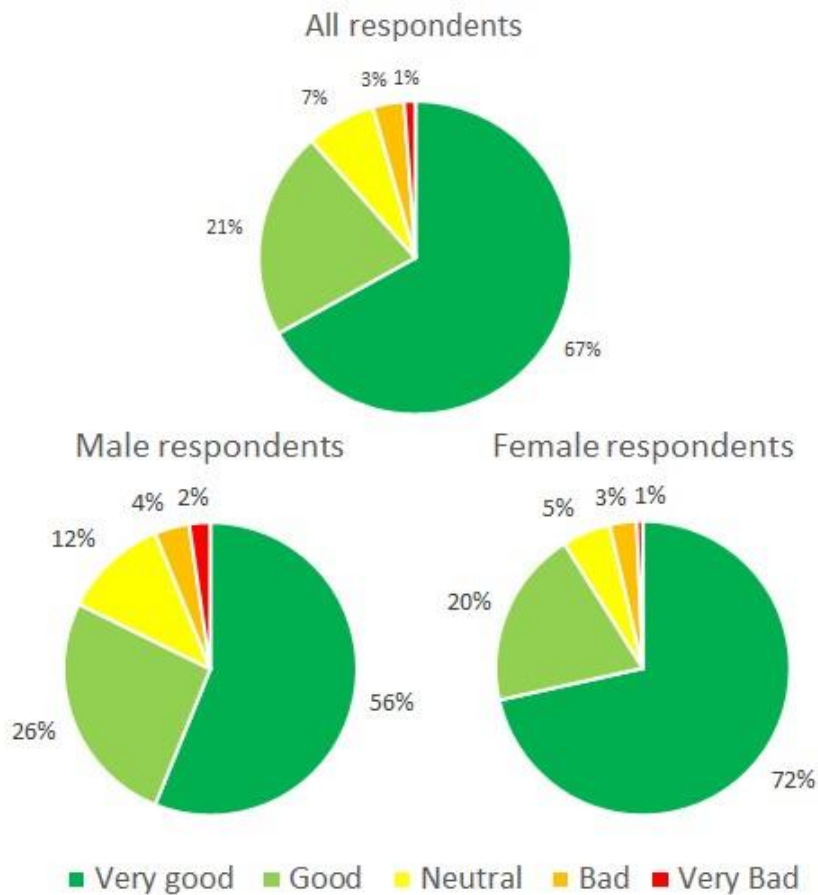


Figure 16: Q34. Do you think that a ban on plastic bags in Utrecht is a good idea? Shown for all respondents, and for the male and female respondents separately.

Explanation

Reactions from respondents who responded positively to the idea of implementing a ban on plastic bags.

Overall, respondents who were positive about the idea of implementing a ban on plastic bags named similar motives relating to environmental reasonings. Sometimes only a general statement about the environmental implications is made (*"Plastic's pretty bad, right?"*, *"Think about the future of my grandchildren"*⁴⁰ or *"Think about the plastic soup"*⁴¹).

Others also mentioned that consumer behaviour should change (*"We need to reduce our plastic consumption & for human behaviour to change then we must restrict options to encourage people to bring their own bag."*, *"As long as it is offered, people continue to buy it. As soon as it is not available anymore people will bring their own bag, because buying a bag each time will become an expensive hobby. I would also make the reusable bags a lot more expensive."*⁴², *"I think that to really make a change, it almost can't be done other than with a ban. You can make the bags more expensive or whatever. But to really make a change, a ban from higher up is almost inevitable."*⁴³ or *"I think this is the best option, deprive people of that choice"*⁴⁴).

Some respondents state how unnecessary plastic bags are, but they do want to have a good alternative for them (*"It is unnecessary to use so much single-use plastic. The unlearning of a service such as providing a bag is not a lot of effort for the consumer. One can expect that everyone has bags that they can use."*⁴⁵, *"I think thin plastic bags for groceries are unnecessary. But I would find it useful to use a plastic bag in my backpack to carry something that can leak (bunch of flowers, pack milk). The ban would make it difficult for me to get hold of such a bag."*⁴⁶ or *"It is unbelievable how often people "unnecessarily" buy a plastic bag that is only used once or twice. People will have to get used to it, but they will naturally learn to always carry a bag with them. However, a non-plastic reusable alternative must always be offered to purchase. And paper shouldn't be given away anymore... Bringing your own is better in the end."*⁴⁷).

⁴⁰ *"Denk aan de toekomst van mijn kleinkinderen"*

⁴¹ *"Denk aan plastic soep"*

⁴² *"Zolang het aangeboden wordt, blijven mensen het kopen. Zodra het er niet meer is gaan mensen zelf een tas meenemen dit omdat iedere keer een tas kopen dan een dure hobby wordt. De herbruikbare tassen zou ik ook een stuk duurder maken."*

⁴³ *"Ik heb het idee om echt een verandering te maken, het bijna niet anders kan dan via een verbod. Je kan wel weer de tassen duurder maken of wat dan ook maar om echt een verandering te maken is een verbod van hogerop bijna onvermijdelijk."*

⁴⁴ *"Dit is denk ik de beste optie, gewoon mensen van die keuze ontdoen"*

⁴⁵ *"Het is onnodig om zoveel plastic te gebruiken met een eenmalige functie. Het afleren van een service zoals een tas aanbieden is weinig moeite voor de consument. Men kan verwachten dat iedereen wel tassen heeft die men gebruiken kan."*

⁴⁶ *"Ik denk dat dunne plastic tassen voor boodschappen overbodig zijn. Wel zou ik het handig vinden om een plastic tas in m'n rugzak te gebruiken om iets mee te nemen wat kan lekken (bos bloemen, pak melk). Door het verbod zou ik moeilijk aan zo'n tas kunnen komen."*

⁴⁷ *"Het is ongelooflijk hoe vaak mensen "onnodig" een plastic tas kopen doe maar 1 of 2x wordt gebruikt. Het zal een kwestie van wennen zijn, maar mensen leren vanzelf altijd een tas bij zich te dragen. Wel moet er altijd een niet-plastic herbruikbaar alternatief worden geboden om te kopen. En geen papier meer weggeven... Zelf meenemen is uiteindelijk toch beter."*

Reactions from respondents who responded neutral to the idea of implementing a ban on plastic bags.

There were several reasons why respondents chose the option neutral in question 34. Some respondents simply did not know what to choose (“*I don’t know*”⁴⁸).

Other respondents thought the idea was good but argued that there is still no good enough alternative for plastic bags (“*I agree, but the paper bag should then be the perfect alternative. And don't give a bag with every potty thing. Stimulate the use of own bags or let people pay. But I don't think it's a good plan to implement a ban without a good alternative.*”⁴⁹).

Some made it clear that it’s especially important how the plastic bag is used, and that consumer behaviour should change (“*It is not about where and how the bags come into circulation, it is about what we do with them afterwards*”⁵⁰ and “*I wonder if this will solve the problem. I don't think that a ban will have a big influence, it's more about people's behaviour. A lot of people just throw something away or on the street. Banning plastic bags, so that they are no longer dumped randomly, is a step in the right direction. But in the end, I think it's much more about awareness of the environment than specific awareness that plastic bags are bad for the environment. You want people to consciously deal with, for example, waste separation and never throw anything on the street or into nature again.*”⁵¹).

Additionally, some respondents said that more awareness should be created, but a ban on plastic bags was still too soon (“*Good to make people more aware of the amount of plastic they use, but a ban is still too early I think.*”⁵²). Respondents further stated that they do not see this as the way to solve the plastic problem and disagree with the way the government deals with problems (“*Feels like a drop in the ocean. GroenLinks policy*”⁵³ and “*Overly interfering government that crosses borders because citizens are lazy and stupid.*”⁵⁴).

⁴⁸ “Weet ik het”

⁴⁹ “*Mag van mij wel, maar dan zou een papierentasje een perfect alternatief zijn. En niet bij elk klein onbenullig ding een tasje meegeven. Stimuleer eigen tassen en indien betalen maar verbod en geen alternatief vind ik geen goed plan. Ik kies daarom optie 1 bij de volgende vraag, maar ben het er niet mee eens*”

⁵⁰ “*Het gaat niet om waar en of hoe de tassen in omloop komen het gaat erom wat we er daarna mee doen*”

⁵¹ “*Ik vraag mij af of dit het probleem gaat oplossen. Ik denk niet zozeer dat het verbod impact heeft, het gaat veel meer over het gedrag van mensen. Veel mensen gooien zomaar iets weg of op straat. Plastic tassen verbieden, zodat die niet meer zomaar random worden gedumpt is een stap in de goede richting. Maar uiteindelijk denk ik dat het veel meer gaat over bewustzijn van de omgeving dan specifiek bewustzijn dat plastic tasjes slecht zijn voor het milieu. Je wilt dat mensen bewust omgaan met bijv afval scheiden en echt nooit meer iets zomaar op straat of in de natuur gooien*”

⁵² “*Goed om mensen bewuster te maken van de hoeveelheid plastic die ze gebruiken, maar verbod is nu nog te vroeg denk ik.*”

⁵³ “*Voelt erg als een druppel op een gloeiende plaat. Groenlinks beleid.*”

⁵⁴ “*Bemoederende overheid die grenzen overstapt omdat burgers lui en dom zijn*”

Reactions from respondents who responded negatively to the idea of implementing a ban on plastic bags.

There were also different motives why respondents disagreed with a possible implementation of a ban on plastic bags. Part of the respondents emphasized that not everything should be banned (“*Stop banning everything. It's good to think about the environment. In addition, the paper alternative is also environmentally harmful.*”⁵⁵ and “*Make people aware of the use of bags but we should not want to regulate everything. So therefore, also no ban on bags.*”⁵⁶). But it was also expressed that there is no good alternative for plastic bags (“*There isn't a good alternative for keeping clothes clean yet. I do my shopping after working hours and don't bring a big bag to the client.*”⁵⁷, “*Bags are logistically necessary. I would much rather see facilities for returning used carrier bags to the supermarket for reuse. Additional or to replace the bin of cardboard boxes you see in some supermarkets*”⁵⁸, “*I find the options limited afterwards... I wouldn't benefit from having ten different fabric shoppers at home, for example if I had to buy one on the spot.*”⁵⁹ or “*I'm forgetful and chaotic sometimes and I'm sometimes struggling to get by.*”⁶⁰.) Others simply did not consider the topic as important (“*Doesn't make any sense*”⁶¹).

Q35. Which one of the three scenarios do you prefer? (Choose 1 option)

The preferred option of the scenarios was number 3, as can be seen in Figure 17. Of all respondents, 38% chose this option, followed by scenario 2 with 30% of all respondents. Female respondents chose scenario 3 more than male respondents (42% of female respondents, 29% of male respondents). The current situation was chosen by 11% of all respondents, and therefore do not prefer the implementation of a ban on plastic carrier bags. Male respondents choose the current situation more often (17%) than female respondents (8%).

⁵⁵ “*Hou op met alles te verbieden. Het is goed dat erover het milieu wordt nagedacht. Daarnaast is ook het papieren alternatief milieubelastend*”

⁵⁶ “*Maak de mensen bewust in het gebruik van tassen maar we moeten niet alles willen regelen. Dus ook geen verbod op tassen.*”

⁵⁷ “*Er is nog geen goed alternatief voor schoon houden kleding. Ik shop na werktijd en neem geen grote tas mee naar de klant*”

⁵⁸ “*Tassen zijn logistiek noodzakelijk. Ik zie veel liever voorzieningen om gebruikte draagtassen in te leveren bij de supermarkt voor hergebruik. Dus ter aanvulling/vervanging van de bak met kartonnen dozen die je in sommige supermarkten ziet.*”

⁵⁹ “*de opties vind ik daarna beperkt... ik heb niks aan thuis tien verschillende stoffen shoppers bijvoorbeeld als ik ter plekke er eentje zou moeten kopen*”

⁶⁰ “*ik ben vergeetachtig en chaotisch soms en heb het niet breed*”

⁶¹ “*Slaat allemaal nergens op*”

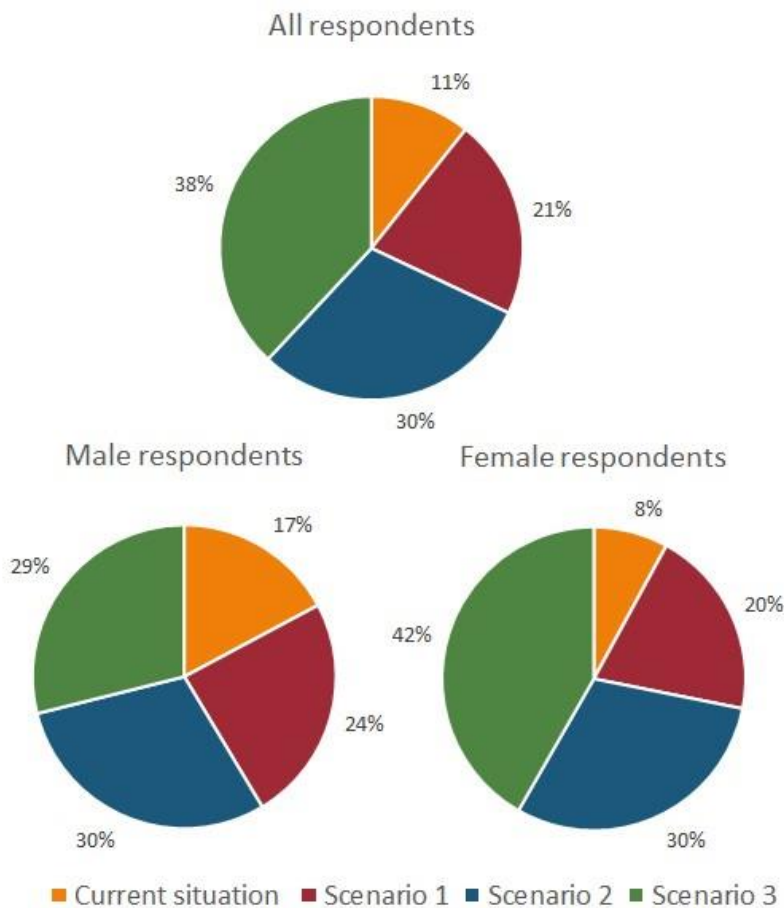


Figure 17: Q35. Which one of the three scenarios do you prefer? Shown for all respondents, and for the male and female respondents separately.

Consistency Q34 Q35

In order to understand if the respondents were consistent in their answers, a consistency check was performed on questions 34 and 35. For this consistency check, respondents' answers to the question 34 and 35 were compared. It could be expected that if a respondent was positive towards a ban on plastic bags, the respondent would also prefer one of the scenario situations (so a change of the status quo). The results are shown in Table 14. Respondents that responded positively on a ban on plastic bags chose for the most part scenario 3. Still, 2% (8 respondents) of the respondents preferred the current situation. Respondents that were neutral preferred mostly the current situation. Respondents that were negative towards the ban also chose the current situation the most. Only 1 respondent that was negative towards a ban on plastic bags chose scenario 3.

Table 14: Consistency between question 34 and 35. The table should be read in rows. Meaning that of the respondents that were positive towards a ban on plastic bags, 2% prefers the current situation etc.

	Current situation	Scenario 1	Scenario 2	Scenario 3
Positive towards ban on plastic bags	2%	23%	33%	42%
Neutral towards ban on plastic bags	68%	16%	13%	3%
Negative towards ban on plastic bags	94%	0%	0%	6%

Change in consumers behaviour due to different scenarios

From questions Q20 onwards, questions about respondents shopping behaviour were repeated. However, the situations in which the questions were asked were changed to scenario situations.

Q13, Q20, Q25 and Q30 When you go to the following stores, which types of bag do you usually use or buy?

In Figure 18 an overview of the responses to the questions Q13, Q20, Q25 and Q30 are presented. It should be noted that in the scenario situations, the plastic bags were no longer given as an option. In addition, the option “I buy the cheapest option available” was not an option in the current situation. Furthermore, the option “Paper bag” was not an option in scenario 2. For all the store types, the percentage that chooses the option “I bring my own bag” increases when going up in the different scenarios. This change is the biggest for the clothing store, where the percentage increases from 48% in the current situation to 83% in scenario 3. The option “other option” decreases when going up in the scenarios. Most common series of answers are presented in Appendix J: Most common series Q13, Q20, Q25 and Q30.

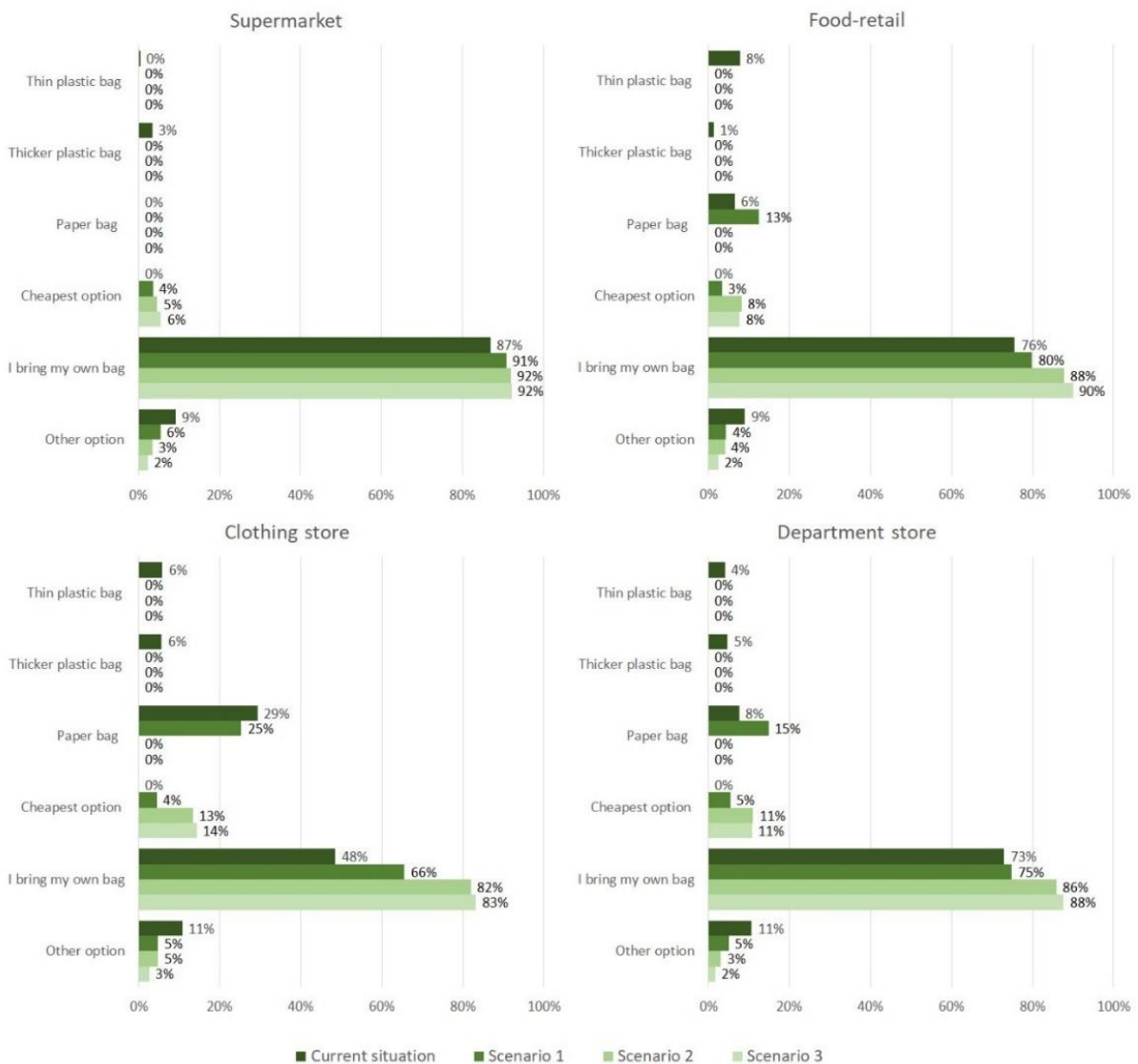


Figure 18: Q13, Q20, Q25 and Q30. When you go to the following stores, which types of bag do you usually use or buy? Comparison of the current situation with the scenario situations. Not all options were always available in the different situations.

Q17, Q22, Q27 How often do you forget to bring your own bag to a store?

In Figure 19 the responses of the different scenarios are presented. It should be noted that the question “How often do you forget to bring your own bag to a store?” was not asked in scenario 3, since it was assumed that there would not be a major difference between scenario 2 and 3. The figure shows that for all the stores the option “Never” is chosen more often in scenario 2 than in the current situation. The change is the biggest for the clothing store, where the percentage of respondents who chose “Never” rises from 31% to 46% of the respondents. When comparing the different stores in scenario 2, it appears that the option “I never bring my own bag” is chosen the most in the clothing store (4%).

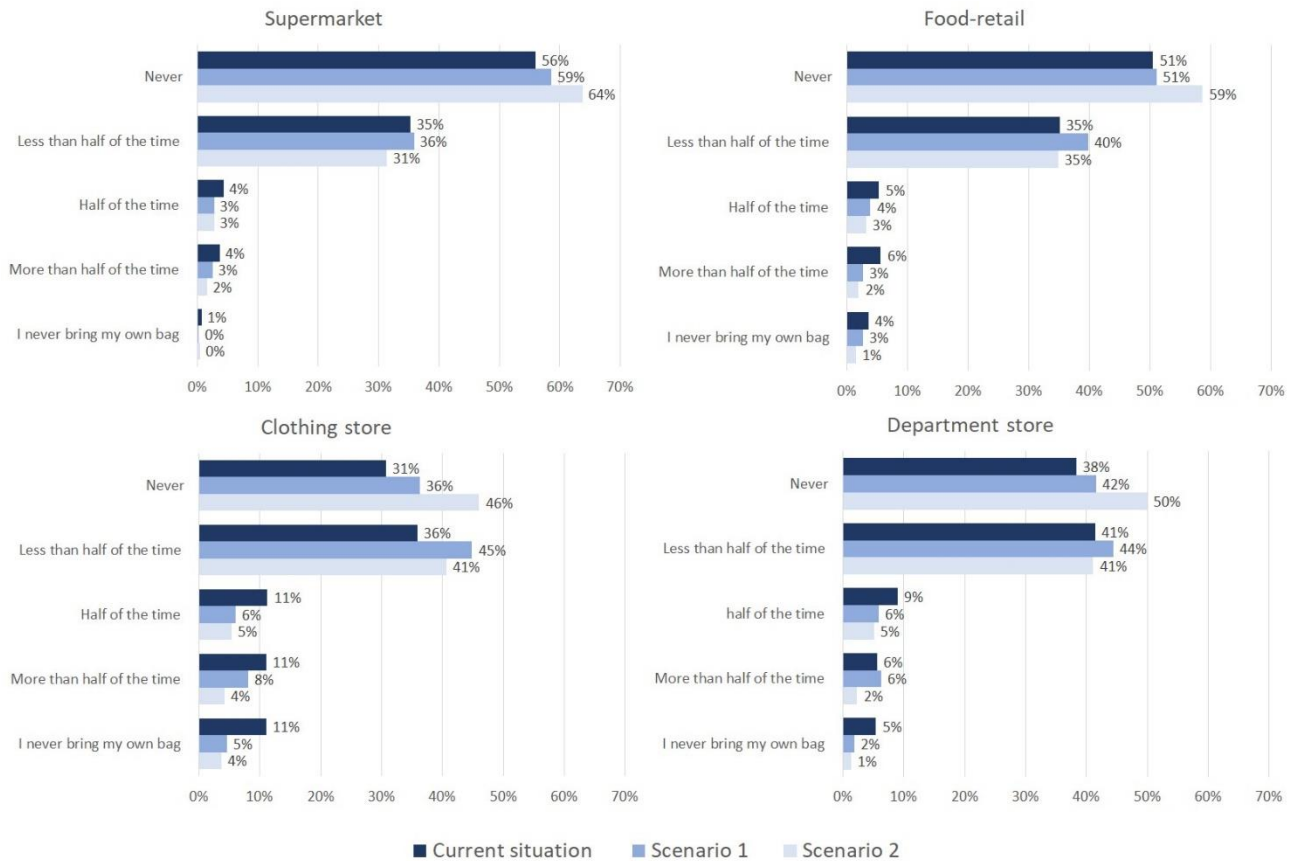


Figure 19: Q17, Q22 and Q27. How often do you forget to bring your own bag to a store? Comparison of the current situation with the scenario situations.

The number of times respondents bring their own bag was determined by using the conversion rate (Section 3.4.1). These results are displayed in Figure 20. Respondents bring their own bag most often to a supermarket (86% of the time in the current situation), followed by the food-retail (81% of the time in the current situation). With the introduction of all scenarios, respondents bring their own bag more frequently.

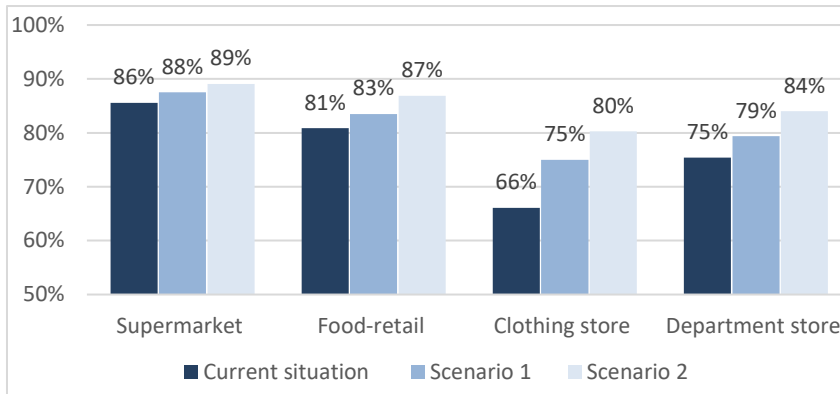


Figure 20: Percentage how often respondents bring their own bag to the different store types.

To look into the consistency of the answers of respondents, the answers to Q17, Q22 and Q27 were compared for each respondent. The most important result from this consistency check is that part of the respondents showed inconsistent answers between the questions Q17, Q22 and Q27. An inconsistent answer is defined in such a way that consumers behaviour deteriorates when implementing a scenario. Number of inconsistent answers fluctuated between 95 (21.7% for the food-retail) and 35 (8% for supermarket). Additionally, the consistency check showed for how many respondents behaviour in the scenario situations improved. These results fluctuated between 69 (15.8%) respondents for the supermarket and 160 (36.6%) for the clothing store. More detailed explanation of the consistency check can be found in Appendix K: Consistency Q17, Q22, Q27.

Q18, Q23, Q28 and Q32 If you forget to bring your own bag, which option would you choose?

In Figure 21, the responses in the various scenarios are shown. For all stores, except the supermarket, the percentage that chooses a paper bag (cheapest option) increases when changing from the current situation to scenario 1. For the supermarket, the percentage that chooses the fabric shopper (cheapest option for the supermarket) increases when changing from the current situation to scenario 1. For all stores, except the supermarket, the percentage that chooses a fabric shopper increases in scenario 3 (cheapest option in that scenario). The changes are smaller for the other types of bags.



Figure 21: Q18, Q23, Q28 and Q32. If you forget to bring your own bag, which option would you choose? Comparison of the current situation with the scenario situations. Not all options were available in all situations.

Q36. Why would you not bring your own bag to a store?

Different reasons were mentioned why respondents would not bring their own bag to a store. Some respondents made it clear that they never forget to bring their own bag (“I always bring my own and am happy to reuse”, “I always bring my own linen bag or backpack”⁶², or “I always bring my own bag. If I forget one, I either come back some other time or I carry it myself.”⁶³).

Others said that the only reason they do not bring their own bag is because they forget to bring it (“None, except that I sometimes forget one.”⁶⁴, “I always take an extra with me, so if I don’t have one it’s because I forgot one and need a bag to get the items with me.”⁶⁵, “The only reasons are that I just forget, or when I do an unplanned purchase and don’t have a carry bag with me. / That’s why having an option for getting bags in the shops is still useful” or “You don’t come directly from home, so you don’t have a bag or you don’t have enough space left, because the travel stuff already occupies all the necessary space.”⁶⁶).

Protecting clothes was another reason mentioned multiple times (“It’s nice when clothes are in a clean bag, and I don’t see any problems with using paper bags.”⁶⁷, “Indeed, I don’t use my own bag for new

⁶² “Ik neem altijd eigen linnen tas of rugzak mee”

⁶³ “Ik neem altijd een eigen tas mee. Als ik er een vergeet, kom ik of een andere keer terug of draag ik het zelf”

⁶⁴ “Geen, behalve dat ik het soms vergeet”

⁶⁵ “Ik neem standaard een extra tas mee, dus als ik het niet heb is het omdat ik het ben vergeten en een tas nodig heb om de spullen mee te krijgen.”

⁶⁶ “Je komt niet direkt van huis, waardoor je geen tas meehebt of niet voldoende plek overhebt, omdat de reisspullen alle nodige ruimte al ik beslag nemen.”

⁶⁷ “Het is fijn als kleding in een schone tas zit, en ik zie geen problemen met het gebruik van papieren tassen.”

clothes. For all other products/shops I do. Strange actually!"⁶⁸, "To protect new clothes and other products that must remain clean"⁶⁹ or "I never thought about bringing bags with me for clothes shopping since I didn't think of paper bags as very environmentally harmful...").

Also, the protection of food items was mentioned multiple times ("It's fresher to put unprotected food in a new clean bag."⁷⁰, "For example with raw chicken (poultier) or fresh fish I prefer to use plastic because my fabric bags will smell like it or because I'm afraid of contamination."⁷¹, "If the food spills in the bag, so it could get dirty." or "It is fresher to have a plastic bag around meat from a butcher"⁷²).

Some respondents also mention their status as reasons for not bringing their own bag or the luxurious feeling of getting a new bag ("I look like a homeless when I walk around with a plastic bag to a clothing store. Supermarket I forget it.", "In a clothing store it is indeed a luxury (beautiful bags), Otherwise no problem. I think that bags will become a status symbol (more attention, more possibility for your own identity)"⁷³, "I hate it when I go shopping, that I have to walk around with such a stupid shopping bag."⁷⁴ or "There is also a nice (luxury) feeling of some new clothing bags."⁷⁵).

Additionally, the convenience of getting a new bag was mentioned multiple times ("Convenience"⁷⁶, "My wife has a foldable bag with her. Ridiculous!"⁷⁷, "Don't feel like lugging my own bag"⁷⁸ or "I prefer to not walk around with a bag if I might not need it. / Also it is just very easy that if you go clothes shopping, and you put your clothes on the counter, you are given a bag containing all your purchased clothes, neatly folded").

Lastly, the service of the store was mentioned multiple times ("I pay more and have less services. This should have a correct chain of the product, from raw materials to the end of the product as residual part or in a circular economy. More implication of the companies, and no more from end-users." and "...Service and hospitality of the department store or clothing store."⁷⁹).

Q37. Why would you bring your own bag?

Mainly three reasons were given why respondents would bring their own bag to a store.

The first reason was environmental consideration, for example: "Better for the environment"⁸⁰, "I have a no single-use plastic policy and preferably no single-use anything (preferably also no paper, although

⁶⁸ "Ik gebruik inderdaad geen eigen tas voor nieuwe kleding. Voor alle andere producten/winkels wel. Raar eigenlijk!"

⁶⁹ "Nieuwe kleding en andere producten die schoon moeten blijven te beschermen."

⁷⁰ "Het is frisser om niet beschermd voedsel in een nieuwe schone tas te doen."

⁷¹ "Bij bijvoorbeeld rauwe kip (poultier) of verse vis gebruik ik liever plastic omdat mijn stoffen tassen ernaar gaan ruiken of omdat ik bang ben voor besmetting."

⁷² "Bij vlees van een slager is het frisser om er een plastic tas omheen te hebben."

⁷³ "in kledingwinkel is het idd luxe (mooie tassen), verder geen probleem. denk, dat tassen een status-symbool worden (meer aandacht, meer mgelijkheid voor identiteit)."

⁷⁴ "Heb een hekel, wanneer ik winkel in de stad, om met zo'n stomme boodschappentas te lopen."

⁷⁵ "Er gaat ook wel een fijn (luxe) gevoel uit van sommige nieuwe kledingtassen."

⁷⁶ "Gemakzucht"

⁷⁷ "Mijn vrouw heeft een opvouwtasje bij zich. Ik nooit belachelijk."

⁷⁸ "Geen zin om te sjouwen met mijn eigen tas"

⁷⁹ "...service en gastvrijheid vh warenhuis of kledingzaak."

⁸⁰ "Beter voor het milieu"

that is usually recyclable). Main reason: environment"⁸¹, "Nonsense to buy a bag when you have enough at home. And the less junk on this earth the better..."⁸² and "Preventing the waste of raw materials"⁸³.

The second reason was economical consideration, for example: "Cheaper"⁸⁴, "Convenient. Saves money. Better for the environment. No extra plastic."⁸⁵, "Reduce the plastic consumption and it's cheaper not to buy a bag"⁸⁶ and "Saves money and bags. Convenient."⁸⁷.

The last reason that was often mentioned was the convenience of alternative bags, such as: "I think it's more convenient than having to carry several different bags"⁸⁸, "My sturdy cotton carrier bag can carry a lot, the handles are more comfortable than plastic ones, I am aware of the impact of plastic on the environment and try to do my bit to reduce it", "I like to walk with a backpack"⁸⁹ or "Safer on the bike, does not break/ tear."⁹⁰.

Q38. Do you have any other idea of how the use of plastic carrier bags could be reduced (other than with a ban)?

A variety of very creative ideas was given as alternatives to reduce the use of plastic carrier bags. First, respondents stressed the importance of having educational campaigns. These campaigns could show the negative effects of using plastic carrier bags ("Inform people more why it's a bad choice"⁹¹, "Information about the idiotic plastic mountain."⁹², "More governmental campaigns to emphasize the negative side of plastic bags. Increase awareness among consumers. Make it more acceptable to transport loose fruit and vegetables in your own reusable bags."⁹³ or "Public campaigns on environmental damage"⁹⁴).

Instead of emphasizing the negative effects, these campaigns could also take a positive stance, for example: "Positive campaigns that discourage consumers. A point/saving system for fun hip bags that can be purchased with the savings campaign from supermarkets. Portraying the positive or saved impact (e.g. you have saved 5 days of drinking water)."⁹⁵, "Create awareness of the consequences of

⁸¹ "Ik heb een no single-use plastic policy en liefst no single-use anything (liefst ook geen papier, al is dat meestal nog te recyclen). Belangrijkste reden: milieu"

⁸² "Onzin om een tas te kopen wanneer je er genoeg thuis hebt. En hoe minder rotzooi op deze aarde hoe beter"

⁸³ "Verspilling van grondstoffen tegengaan"

⁸⁴ "Goedkoper"

⁸⁵ "Handig. Spaart geld. Beter voor het milieu. Geen extra plastic."

⁸⁶ "Het plasticverbruik te verminderen en goedkoper om geen tas te kopen"

⁸⁷ "Scheelt geld en tasje. Handig"

⁸⁸ "vind ik handiger dan allemaal verschillende tassen te moeten dragen"

⁸⁹ "Ik vind het prettig om met een rugzak te lopen"

⁹⁰ "Veiliger op de fiets, breekt/scheurt niet."

⁹¹ "Mensen meer informeren over waarom het een slechte keus is"

⁹² "Voorlichting over de idiote plasticberg."

⁹³ "Meer campagnes vanuit de overheid om negatieve kant van plastic tassen te benadrukken. vergroten bewustzijn onder consumenten. Vervoeren van losse fruit en groenten in eigen herbruikbare tas of netje geaccepteerder maken."

⁹⁴ "Publiekscampagnes over milieuschade"

⁹⁵ "positieve campagnes die de consument ontmoedigen. een puntsysteem / spaar systeem voor leuke hippe tassen die men kan aanschaffen als spaaractie voor de supermarkten. het portretteren van de positieve of gespaarde impact (bijv. U heeft 5 dagen drinkwater bespaard)"

(single) use plastic in a positive way. So not a picture of a stomach with plastic in it, but something along the lines of "you saved this much CO2 by not choosing a plastic carrier bag".⁹⁶ or "Promote and/or provide/distribute more alternatives. Possession promotes use."⁹⁷.

Another alternative approach mentioned is that the motive on plastic bags should change. Either by prohibiting the printing of a store's logo on the bag ("If shops are no longer allowed to print their logo on the bag, they will not be used as advertising."⁹⁸ or "Prohibit advertisement on bags, often they are also distributed for that reason, I think"⁹⁹), or by making the bags an embarrassing item ("Place images of how harmful plastic is to the ecosystem on the plastic bags (e.g. by statistics, dead fish) / Like cigarette packets, it could scare people off"¹⁰⁰, "Place pictures of pathetic entangled turtles on the plastic bag with caption: "plastic is deadly". Just like packs of cigarettes."¹⁰¹ or "Higher taxes, educational campaigns, show pictures of turtles which are stuck in a plastic bag so that they cannot grow anymore. Print the pictures of the turtles on the plastic bags, PLASTIC BAGS ARE DEADLY! Campaign all over Utrecht, make them morally condemned. People must feel bad for using them."¹⁰²).

Also, reward systems are mentioned by respondents such as: "A financial incentive (rather than not being financially punished), such as 25 cents off with each purchase if you bring your own bag" or "As mentioned, a shop-chain in my home country gives each customer a bonus point when they use their own bag/reusable bag. These points can be taken out as cashback at the end of the year. It is also imaginable that instead of money, customers could receive discounts and other awards...". Additionally, it was proposed that longer lasting bags should be promoted ("Subsidized cotton or jute bags, which makes them cheaper than plastic bags."¹⁰³ or "One-time free distribution of foldable bags?"¹⁰⁴).

Respondents also said that the placement of bags in stores should change ("Influence on behaviour: do not place plastic bags visibly in the shop. Only give a bag when requested..."¹⁰⁵, "Don't place bags where they can easily be grabbed, for example at Jumbo (Supermarket), the bags are visible, which makes it easy to take a bag."¹⁰⁶ or "If they are placed at the beginning of the story (so not at the cash register), then people have to think a bit more. Also if bags that have been used can be handed in and then be picked up for free afterwards.").

⁹⁶ "Bewustwording van het gevolg van (eenmalig) gebruik van plastic op een positieve manier. Dus niet een foto van een maag met plastic erin, maar iets in de trant van "je hebt zoveel CO2 bespaart door niet te kiezen voor een plastic draagtas"."

⁹⁷ "Alternatieven meer promoten en/of verstrekken/uitdelen. Bezit bevordert gebruik."

⁹⁸ "Als winkles niet meer hun logo op de tas mogen drukken worden ze ook niet gebruikt als reclame"

⁹⁹ "verbied reclame op tassen, ze worden ook vak om die reden uitgedeelt denk ik"

¹⁰⁰ "Op de plastic tassen afbeeldingen plaatsen van hoe plastic schadelijk is voor het ecosysteem (bijvoorbeeld door statistieken, dode vissen) / Net zoals bij pakjes sigaretten het zou mensen kunnen afschrikken"

¹⁰¹ "Plaatjes van zielige verstrikte schilpadden op de plastic tas met onderschrift: "plastic is dodelijk". Net zoals met pakjes sigaretten"

¹⁰² "Higher taxes, educational campaigns, show pictures of turtles which are stuck in a plastic bag so that they cannot grow anymore. Print the pictures of the turtles on the plastic bags, PLASTIC ZAKJES ZIJN DODELIJK! Campaign all over Utrecht, make them morally condemned. People must feel bad for using them."

¹⁰³ "Gesubsidieerde katoenen of jute tassen waardoor deze goedkoper zijn dan plastic tassen."

¹⁰⁴ "Eenmalig gratis opvouwbare tasjes uitdelen?"

¹⁰⁵ "Gedragsbeïnvloeding: plastic tassen niet zichtbaar opstellen in de winkel. Alleen bij navraag de mogelijkheid om tassen mee te nemen..."

¹⁰⁶ "niet meer voor het pakken hangen. bijv. bij jumbo zie je ze, dus is het makkelijker om een tasje te pakken"

Moreover, the implementation of a return systems was suggested. This could either be by a deposit system (*“Offer a return credit option like they do with some bottles and glass containers.”*, *“Strong bags with a deposit. The most common scenario where I have to buy a bag is when I forgot a bag or didn't expect to need one beforehand. I've got plenty of bags at home already. So I don't need any extra bags.”*¹⁰⁷ or *“The Zeeman had a good option. They had foldable bags that you could buy for €1 deposit. Then you could return the bag and get your money back. Would be great if all the shops participate in this by a governmental subsidized action. And that you could return your bag to all the stores.”*¹⁰⁸) or by a lending system (*“Facilitate return points for used plastic bags and shoppers. Many people have dozens of bags and shoppers at home but didn't bring them to (for example) the supermarket. By offering used plastic bags free of charge, you extend the lifespan of a plastic bag, and therefore reduce the production needed to meet the demand.”*¹⁰⁹, *“In Germany, stores often have a coat rack with fabric bags for when you have forgotten your bag. You can take these free of charge. You can also leave the bags that you don't need for someone else.”*¹¹⁰ or *“Reuse of other bags. For example, set up loan bags at supermarkets. You can take big shoppers for free and when you have too many you can bring them back.”*¹¹¹).

It was also mentioned multiple times that the plastic bags should be replaced with paper bags (*“Back to paper packaging or environmentally friendly packaging”*¹¹², *“Simply replace them by paper bags”* or *“Not all stores offer paper bags, that could be improved.”*¹¹³) or that the plastic bags should be more expensive (*“Make them ridiculously expensive so that people get the cost it has on the environment and find it to expensive to buy it. It would still feel like an option ro people and not like a ban. Just very few people would probably choose to buy a thin plastic bag as expensive as their whole purchase”*, *“Tax the everloving hell out of them.”* or *“Make people pay 20 euro per bag. Then I won't forget to bring a bag”*¹¹⁴).

Lastly, respondents proposed that plastic bags shouldn't be produced anymore (*“Stop making them”*, *“Prohibition of production”*¹¹⁵ or *“Just don't make them”*) or that a ban on plastic carrier bags is the best option (*“BAN THEM. The Netherlands is behind countries like Kenya and Rwanda, who have*

¹⁰⁷ *“Goede tassen met statiegeld. Meest voorkomende scenario wanneer ik een tas moet kopen is wanneer ik een tas vergeten ben, of vak te voren niet had verwacht had een tas nodig te hebben. Ik heb echter al ruim genoeg tassen thuis. Dus heb geen extra tassen in eigendom nodig”*

¹⁰⁸ *“De zeeman had een goede optie. Van die opvouwbare tassen die je voor €1 statiegeld kon kopen. Vervolgens mocht je de tas ook weer inleveren en kon je je geld terug krijgen. Zou super zijn als alle winkels hier aan meedoen in een gemeente gesubsidieerde actie. En dat je je tas dan ook bij alle winkels weer kon inleveren.”*

¹⁰⁹ *“Het faciliteren van inleverpunten voor gebruikte plastic tassen en shoppers. Veel mensen hebben tientallen tassen en shoppers in huis, maar hebben ze (bijvoorbeeld) in de supermarkt niet bij de hand. Door kostenlos gebruikte plastic tassen aan te bieden verleng je de levensduur van een plastic tas, en verminder je dus ook de benodigde productie om aan de vraag te voldoen.”*

¹¹⁰ *“In Duitsland staat in winkels vaak een kapstok met stoffen tasjes voor als je je tasje vergeten bent. Deze mag je gratis meenemen. Ook kun je hier dan de tasjes die je over hebt een volgende keer achter laten voor een ander.”*

¹¹¹ *“Hergebruik van ander soort tassen. Bijvoorbeeld bij supermarkten leentassen instellen. Je kunt je grote shoppers gratis meenemen en wanneer je er teveel hebt neem je ze weer mee.”*

¹¹² *“Terug naar papieren verpakking of milieuvriendelijke verpakking”*

¹¹³ *“Lang niet alle winkels bieden papieren tassen aan, dat kan beter”*

¹¹⁴ *“20 euro per tas laten betalen. Dan zal ik het niet snel vergeten een tas mee te nemen”*

¹¹⁵ *“Verbieden van produceren”*

already done so.”, “Without a ban I think it will be difficult- because the price will always be a big decision factor. To somehow bring people to always carry around a reusable bag could be a solution- but changing the mindset of society will take longer than putting a ban”, “No. Unfortunately human needs to be stopped by using (hard) regulations. All the news about animals suffer from plastic waste helped me to realised the issue but still in general people need strict regulations.” or “No, humans are stubborn, and the bags remain useful, no matter what you think.”¹¹⁶).

¹¹⁶ *“Nee, de mens is hardnekkig, en de tasjes blijven handig, wat je er ook van denkt.”*

4.3 Number of bags purchased in the city of Utrecht

The next section shows the monthly purchase of carrier bags in the city of Utrecht. Additionally, it is shown how the purchase of the different bags is dispersed among the different store types included in the study. Also, the distribution of the purchase of the different bags among the different socio-demographic characteristics is shown.

4.3.1 Purchase of different carrier bags

In Table 15 the results of the monthly purchase of carrier bags by the inhabitants of the city of Utrecht are shown. These results were determined by extrapolating survey results to the city of Utrecht according to the method described in Section 3.4. Additionally, the percentual change of the number of bags used by the participants for each scenario are shown. For the ease of interpreting, an average yearly purchase per person was also determined.

A list of assumptions and adjustments of survey responses can be found in Appendix I: Survey respondent adjustments. Next to this, some unrealistic high purchases of bags were deleted from the survey. These outliers are included in the appendix as well. The difference in results of survey responses that were included without alteration can be found in Appendix L: Difference in survey response by adjustments.

Table 15: Total number of bags, percentual change and average per person of the purchased bags in the current situation and scenario situations in the city of Utrecht. The number of bags is shown for each month but the average per person is shown per year. The percentual change is compared to the current situation.

		Current situation	Scenario 1	Scenario 2	Scenario 3
HDPE bag	<i>Number of bags per month</i>	293390	0	0	0
	<i>Percentual change</i>		-100%	-100%	-100%
	<i>Average per person per year</i>	12.02	0	0	0
LDPE bag	<i>Number of bags per month</i>	535725	0	0	0
	<i>Percentual change</i>		-100%	-100%	-100%
	<i>Average per person per year</i>	21.95	0	0	0
Paper bag	<i>Number of bags per month</i>	226635	311793	264819	0
	<i>Percentual change</i>		+38%	+17%	-100%
	<i>Average per person per year</i>	9.29	12.78	10.85	0
PP non-woven	<i>Number of bags per month</i>	26638	373639	420022	513901
	<i>Percentual change</i>		+1303%	+1477%	+1829%
	<i>Average per person per year</i>	1.09	15.31	17.21	21.06
PP woven	<i>Number of bags per month</i>	39324	159477	133213	146162
	<i>Percentual change</i>		+306%	+239%	+272%
	<i>Average per person per year</i>	1.61	6.53	5.46	5.99
PET bag	<i>Number of bags per month</i>	7339	64159	51707	61659
	<i>Percentual change</i>		+774%	+605%	+740%
	<i>Average per person per year</i>	0.30	2.63	2.12	2.53

Jute bag	<i>Number of bags per month</i>	6359	98436	32226	45513
	<i>Percentual change</i>		+1448%	+407%	+616%
	<i>Average per person per year</i>	0.26	4.03	1.32	1.86
Cotton bag	<i>Number of bags per month</i>	761	18896	19980	14925
	<i>Percentual change</i>		+2383%	+2526%	+1862%
	<i>Average per person per year</i>	0.03	0.77	0.82	0.61
Total	<i>Number of bags per month</i>	1136170	1026401	921967	782160
	<i>Percentual change</i>		-10%	-19%	-31%
	<i>Average per person per month</i>	3.88	3.51	3.15	2.67
	<i>Average per person per year</i>	46.55	42.06	37.78	32.05

In the current situation, 46.55 carrier bags are purchased annually per person. This number consists of 33.97 plastic bags, 9.29 paper bags and 1.68 bags for multiple use. The current calculated monthly purchase of plastic bags in the city of Utrecht is 829115 bags (293390 + 535725).

For all bag types beside plastic, the purchase of the bags increases in the different scenarios. A substantial increase can be observed in the purchase of PP non-woven, jute- and cotton bags. The cotton bags had the largest increase. However, the number of bags is still relatively low compared to the other bag types (yearly purchase of 0.61 bags per person). The same holds for the jute bags, although the starting point is already a lot higher (yearly purchase of 1.86 bags per person). The number PP non-woven were high to begin with but increases greatly in each scenario. This is mainly due to the fact that these bags are the most common in supermarkets. Additionally, the supermarket is the store most often visited and where most bags are purchased. Strikingly, the paper bag has the lowest increase in all the scenarios, even though this is the cheapest option of all bags in this study. This is once again because most bags are purchased in the supermarket. In supermarkets the paper bag was not given as an option. In scenario 3, the number of PP non-woven bags is similar to the number of LDPE bags in the current situation, which leads to a yearly purchase of 21.06 bags per person. The PP non-woven is the cheapest option in the supermarket. Next to the PP non-woven, the PP woven also has a high number of bags purchased in scenario 3, with a yearly purchase of 5.99 bags per person.

The results also show that that total amount of bags purchased decrease in all researched scenarios. In the current situation, on average, 46.55 bags are purchased per person each year. These bags are divided between the different options, where the highest purchase in the current situation is the LDPE bag. With each scenario the number of bags decreases with about 10%. The highest decrease is in scenario 3 with a decrease of 31%, compared to the current situation. This is due to the fact that in scenario 3, respondents choose "other option" more often. In the scenarios, the bag that is purchased most often is the PP non-woven.

Comparison of results with other studies

Unfortunately, only little data is available on the purchase of carrier bags in the Netherlands. Therefore, it is hard to compare the results from this study. On the 2nd of March 2020, new results were published about the use of carrier bags in the Netherlands (I&O Research, 2020). In their report it was mentioned that the number of plastic carrier bags used was approximately 600 million. This amounts to 35 plastic carrier bags per person per year. These 35 plastic carrier bags consist of 15 thin

plastic bags (comparable to the HDPE bag), 15 thicker plastic bags (comparable to the LDPE bag) and 5 thick plastic bags (comparable to the PP woven bag). Similar results were found in this study, the amount of thin plastic bags is a bit lower (12 bags in this study compared to 15 bags in the report of I&O Research). The amount of thicker plastic bag is a bit higher (22 compared to 15 bags) and the amount of thick plastic bags is lower in this study. In the study of I&O Research (2020) laminated paper bags were included in the category of thicker plastic bags and therefore it is not possible to compare these results directly. Data on other types of carrier bags (such as the cotton and Jute bags) are not available and therefore no reference numbers are available.

4.3.2 Comparison of different store types

In Figure 22 the distribution of the purchased bags in the different store types are shown for the current situation and the different scenarios. The data shows that for all situations most carrier bags are purchased in the supermarket. In Appendix M: Distribution of carrier bags among different stores and Appendix N: Distribution of the different bags within the store types extensive tables are shown that show how the different carrier bags are distributed between the different store types. In these tables it can be observed that carrier bags are bought most frequently in the supermarket. Also, which bag is preferred in each store type can be observed. In the scenarios the cheapest option available is the most preferred option for all store types.

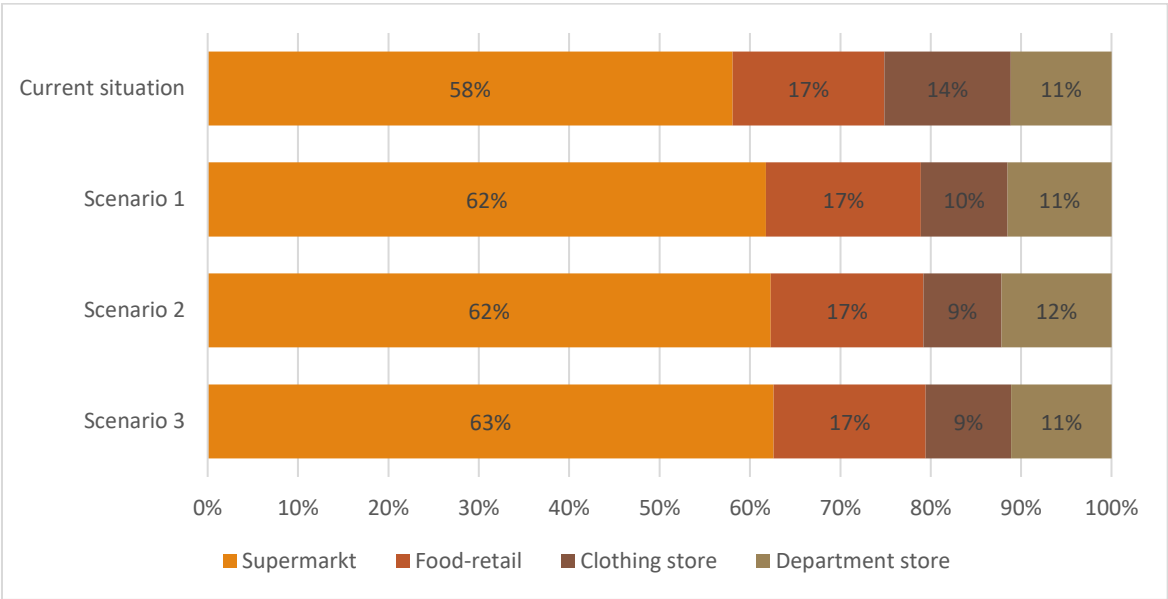


Figure 22: Distribution of purchased carrier bags in the different store types.

Figure 23 shows the decrease of the total amount of carrier bags in the different store types. The biggest decrease in number of bags is in the clothing store, where the number of bags decreases with 53% in scenario 3 compared to the current situation. The smallest decrease in number of carrier bags is in the supermarket, where the number of carrier bags decrease with 26% (in scenario 3) compared to the current situation.

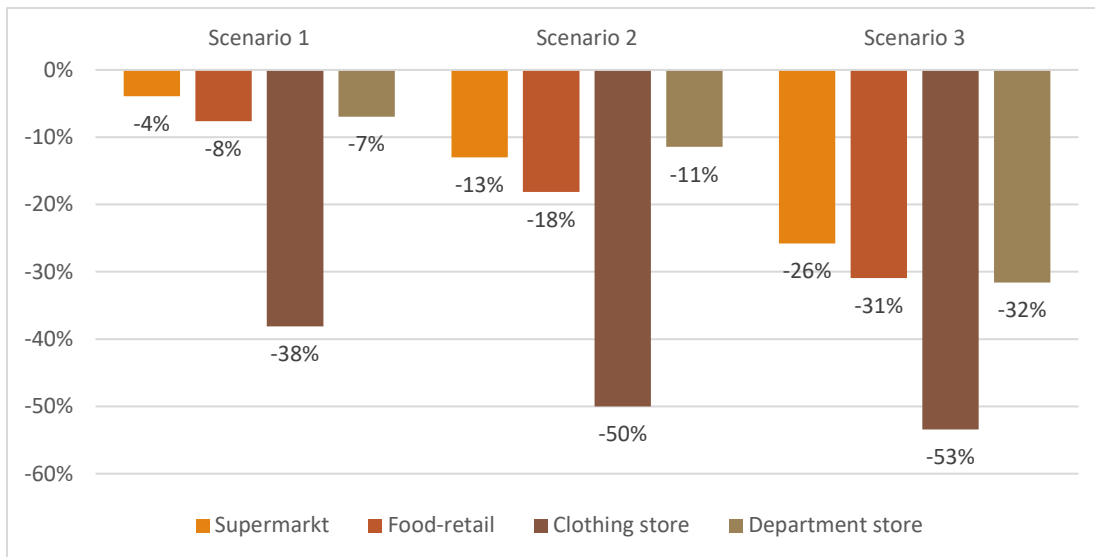


Figure 23: Decrease of number of purchased carrier bags in scenario situations. The values are compared to the current situation.

4.3.3 Comparison of different socio-demographic characteristics

Gender

Table 16, shows the distribution of the number of bags used between males and females. The results show that there is almost an even distribution between males and females.

Table 16: Distribution of the number of bags among males and female.

	Male	Female
Current situation	53%	47%
Scenario 1	54%	46%
Scenario 2	49%	51%
Scenario 3	51%	49%

In Table 17, the percentual change of the number of bags purchased by males and females are shown. These results show that scenario 3 had a bigger effect on males (which showed a reduction of 35%) than on females (which showed a reduction of 27%). Next to this, males already showed a relatively high reduction in scenario 2 (25%), while for females this percentage of decrease was reached by implementing scenario 3 (27% reduction).

Table 17: Percentual change of the total number of bags purchases by males and females. Scenario situations are compared to the current situation.

	Male	Female
Scenario 1	-8%	-11%
Scenario 2	-25%	-12%
Scenario 3	-35%	-27%

Age

In Figure 24 the distribution of the total amount of bags purchased in Utrecht between the different age groups can be found. Most of the bags are purchased in the age groups 26 – 35 and 15 – 25. This holds in all the scenarios. The age brackets also comprise the largest number of inhabitants in Utrecht (WistUdata, 2020).

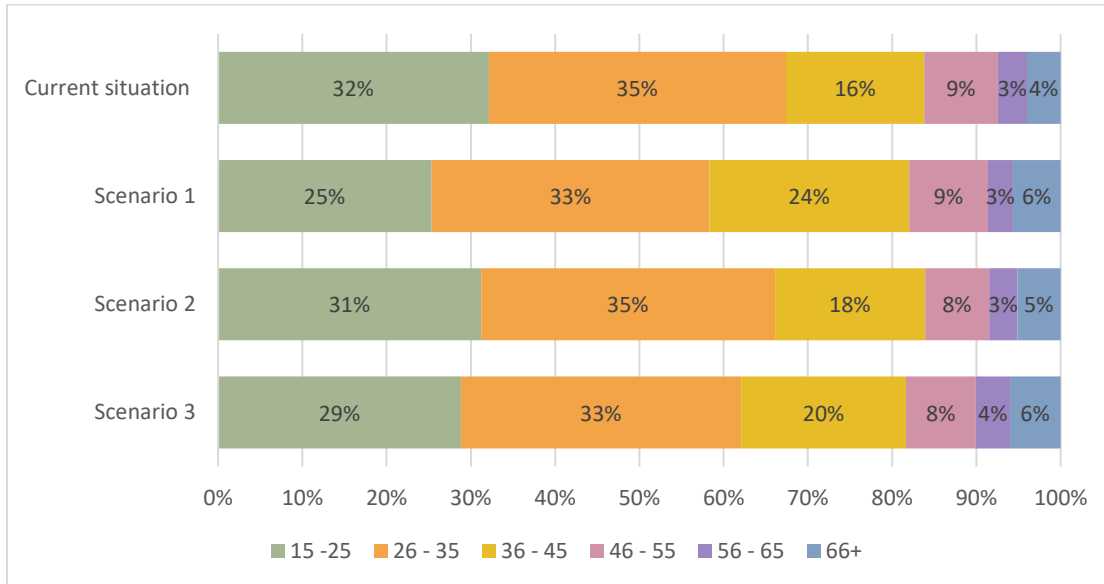


Figure 24: Distribution of total number of bags between the different age categories.

In Table 18 the change in the number of bags purchased in the different age groups are shown. The age groups 15- 25, 26 – 35 and 46 – 55 show a similar decrease in number of bags purchased (35% - 38% decrease). For the age categories 36 – 45 and 56 – 65 the decrease is lower (18% decrease). The age category 66+ shows an increase in number of bags purchased. This increase can be explained by the fact that some of the respondents answered inconsistent in questions how often they forget to bring their own bag to the store. Since the number of respondents in this age group was small. The inconsistent answers had a substantial effect on the total number of bags. Also, the age category 36-45 shows an increase in bags in scenario 1, this also is due to inconsistent answers in the question how often they forget to bring their bag to the supermarket.

Table 18: Percentual change of the total number of bags purchases by the different age categories. Scenario situations are compared to the current situation.

	15 -25	26 - 35	36 - 45	46 - 55	56 - 65	66+
Scenario 1	-29%	-15%	+30%	-3%	-23%	+28%
Scenario 2	-21%	-20%	-12%	-29%	-21%	+4%
Scenario 3	-38%	-35%	-18%	-35%	-18%	+3%

4.4 Screening LCA and littering potential

4.4.1 Screening LCA

Results of the calculation of the environmental impact of “Carrying of purchased goods from supermarkets, food-retail, clothing and department stores, by consumers in the city of Utrecht to their home, over the period of one month” are shown in Table 19. The table also shows the percentual increase/decrease of the situation compared to the current situation.

The environmental impact in most of the impact categories increases when one of the scenarios is implemented. The main reason for this increase is due to the shift to different carrying bags. In 9 out of 10 impact categories the HDPE bag has the lowest impact. Although the number of bags decrease in the scenarios, this decrease does not outweigh the higher values of the categories of the alternative bags.

Only for the impact category agricultural land occupation the impact decreases when implementing scenario 3. In the impact category agricultural land occupation, the HDPE and LDPE bag have the smallest impact. But since the total amount of bags decreases in scenario 3 and most of the bags chosen in the scenario are the PP non-woven and pp woven (which have the lowest impact after HDPE and LDPE bags) this impact category decreases.

Scenario 2 is preferred for the impact categories climate change, terrestrial acidification and marine eutrophication. The impact in climate change is lower in scenario 2 than in scenario 1 because the number of purchased bags decreases. In scenario 3, the number of purchased bags also decrease, but the paper bags (which have a very low impact in the category climate change) are substituted by other bags with higher impact in climate change. This leads to higher impacts in climate change for scenario 3 than for scenario 2.

For the impact category terrestrial acidification and marine eutrophication, the combination of the increase and decrease of all the different bags lead to the results, and no clear bag leading to the increase can be identified. For the other categories, scenario 3 is preferred if a scenario is implemented, since the number of bags decreases the most in this scenario.

The largest increase of impact can be observed in the impact category ozone depletion, whose impact increases 2635% in scenario 1 and 1939% in scenario 3 with respect to the current situation. Also, terrestrial ecotoxicity increases significantly with an increase of 1536% in scenario 1 and an increase of 1165% in scenario 3.

Table 19: Results impact categories for the current situation and the scenario situations. The value between brackets is the percentual change of the value in the scenario situation compared to the current situation.

Impact category	Climate change	Ozone depletion	Terrestrial acidification	Freshwater eutrophication	Marine eutrophication	Human toxicity	Terrestrial ecotoxicity	Agricultural land occupation	Urban land occupation	Water depletion
Unit	Kg CO ₂ -eq	Kg CFC 11 eq.	Kg SO ₂ -eq	Kg P-eq	Kg N-eq.	Kg 1,4-DCB-eq.	Kg SO ₂ -eq.	m ² a	m ² a	m ³
Current situation	118476.20	0.005	628.23	11.40	28.04	17869.45	17.14	48662.66	898.90	940.71
Scenario 1	390794.61 (+ 230%)	0.141 (+ 2635%)	2258.24 (+ 259 %)	54.93 (+ 382%)	160.41 (+ 472%)	56742.91 (+ 218%)	280.28 (+ 1536%)	99029.25 (+ 104%)	2359.21 (+ 162%)	8983.83 (+ 855%)
Scenario 2	343876.98 (+ 190)	0.148 (+ 2663%)	1784.20 (+ 184%)	32.32 (+ 184%)	108.00 (+ 285%)	42118.19 (+ 136%)	289.62 (+ 1590)	75049.35 (+ 54%)	1698.71 (+ 89%)	5373.72 (+ 471%)
Scenario 3	386656.40 (+ 226%)	0.109 (+ 1939%)	1961.67 (+ 212%)	29.47 (+ 159%)	110.90 (+ 296%)	41393.97 (+ 132%)	216.78 (+ 1165%)	22121.71 (- 55%)	1257.26 (+ 40%)	4925.25 (+ 424%)

Comparison different scenarios.

In order to compare the environmental impact of the different scenarios the results of the screening LCA had to be expressed in shadow costs else no comparison could be made. The total environmental impacts expressed in shadow costs are shown in Table 20 (complete table with the different impact categories can be found in Appendix O: Shadow cost per impact category for the different scenarios). The table also shows the percentual change between the scenario situations and the current situation. For all the scenarios the shadow costs increase compared to the current situation. This increase is the lowest for scenario 3, which has an increase of 112%, while in this scenario the number of bags decreased with 31%.

The impact categories climate change, agricultural land occupation and water depletion are the three biggest contributors in the shadow costs. Where the impact category agricultural land occupation is the biggest contributor in the current situation (47%), followed by climate change (30%) and water depletion (10%). This changes in the scenario situations, in scenario 3 the biggest contributor is climate change (47%) followed by water depletion (24%) and agricultural land occupation (10%).

The big difference between the current situations and scenario 3 for the impact category agricultural land occupation can be explained by the fact that the paper bags have a large impact in this impact category. Since these bags are removed in scenario 3 the impact decreases significantly.

The category water depletion, increases from the current situation to the scenario situations since the HDPE and PDPE bags have a very low impact in that category, which are removed in the scenarios and are replaced by bags that have larger impacts in the category water depletion.

The two categories that increase the most in the scenario situations (ozone depletion and terrestrial ecotoxicity) do not show a large contribution to the total shadow costs.

Table 20: Comparison of different scenarios by using shadow costs. The value between brackets shows the percentual change between the current situation and the scenario situations.

Shadow costs	Current situation	Scenario 1	Scenario 2	Scenario 3
Total [€]	9723.25	33361.03 (+ 243%)	24974.97 (+ 157%)	20614.01 (+ 112%)

Comparison different store types

In Table 21 the environmental impact of the purchase of carrier bags, expressed in shadow costs, is shown for the different store types. The table also shows the share of a store type of the total shadow costs of a scenario. In every scenario, the supermarket has the biggest share of the environmental impact. This share almost doubles when changing from the current situation to the scenario situations. After the supermarket, the food-retail had the biggest environmental impact. The clothing store and the department store have the lowest share in environmental impact.

The distribution of the environmental impact is comparable to the distribution of bags among the different stores as presented in Section 4.3.

Table 21: Shadow costs divided among the different store types. The value between brackets shows the percentage of a stores shadow costs of the total shadow costs.

	Supermarket	Food-retail	Clothing store	Department store
Shadow costs [€]				
Current situation	3359.11 (35%)	1904.50 (20%)	2814.08 (29%)	1645.55 (17%)
Scenario 1	22314.93 (67%)	4855.85 (15%)	2757.53 (8%)	3432.72 (10%)
Scenario 2	16831.00 (67%)	3401.13 (14%)	1908.40 (8%)	2834.44 (11%)
Scenario 3	14103.87 (68%)	2901.58 (14%)	1795.68 (9%)	1812.90 (9%)

In Table 22 the percentual increase or decrease of the environmental impact of the scenarios is shown per store type. Every scenario is compared with the current situation. The table shows that the supermarket has the highest increase in the environmental impact for all scenarios. Only the clothing store show a decrease in environmental impact compared to the current situation, the clothing store also showed the largest decrease in number of bags in Section 4.3. In the department store, the increase in environmental impact in scenario 3 is relatively small (10% increase) compared to the supermarket (320%) and food-retail (52%).

Table 22: Percentual change of the shadow costs for the different stores. The values are compared to the current situation.

	Supermarket	Food-retail	Clothing store	Department store
Shadow costs				
Scenario 1	+564%	+155%	-2%	+109%
Scenario 2	+401%	+79%	-32%	+72%
Scenario 3	+320%	+52%	-36%	+10%

4.4.2 Littering potential

Table 23 shows the results of the ranking of the different bags based on the littering potential. The results of the calculations of the littering potential can be found in Appendix P: Results littering potential.

Table 23: Results of the Littering potential. The table only shows the ranking of the different bags.

Combination	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
HDPE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LDPE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Paper	3	3	6	6	6	3	3	6	6	6	3	3	6	6	6
PP non-woven	5	5	4	4	4	5	5	4	4	4	5	5	4	4	4
PP woven	6	6	5	5	5	6	6	5	5	5	6	6	5	5	5
PET	4	4	3	3	3	4	4	3	3	3	4	4	3	3	3
Jute	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Cotton	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

Results are shown for the 15 different combinations of weight and surface of the carrier bags. It can be seen that the ranking of the paper bag, PP non-woven, PP woven and PET bag changes for the different combinations of weights and surface of the bag, while the ranking for the HDPE, LDPE, jute and cotton bags stay the same for all the combinations. Therefore, with the current calculation of the littering potential, the thin plastic bag is ranked as the type of bag with the highest littering potential. The jute bag is the bag with the lowest littering potential. The result that the HDPE bag has the highest littering potential followed by the LDPE bag is similar as in the study by Civancik-Uslu et al. (2019).

Comparing littering potential in different scenario situations

To enable the comparison of the littering potential of different scenario situations, a dimensionless littering value was assigned to each type of bag. This littering value is shown in Table 24, the value was based on the ranking of the bags in Table 23. Since the ranking of the paper, PP non-woven, PP woven and PET bag was fluctuating, the same littering potential value was assigned to these bags.

Table 24: Littering value, based on ranking of different bags.

	Littering value
HDPE	1
LDPE	0.8
Paper	0.6
PP non-woven	0.6
PP woven	0.6
PET	0.6
Jute	0.2
Cotton	0.4

The littering value was multiplied with the number of bags purchased in the city of Utrecht. The results are presented in Table 25. These results show that the littering value decreases for all scenario situations. The highest decrease in littering can be observed in scenario three, where the value decreases 50%.

Table 25: Littering value for current situation and scenario situations.

	Current situation	Scenario 1	Scenario 2	Scenario 3
HDPE	293389.6	0	0	0
LDPE	428579.6	0	0	0
Paper bags	135980.8	187076.1	158891.5	0
PP non-woven	15982.6	224183.5	252013.3	308340.8
PP woven	23594.7	95686.3	79928.0	87697.0
PET	4403.1	38495.6	31024.0	36995.7
Jute bag	1271.9	19687.2	6445.1	9102.5
Cotton bag	304.4	7558.3	7991.9	5970.1
Total	903506.7	572686.9	536293.8	448106.0
Percentual change		-37%	-41%	-50%

5. Sensitivity Analysis

Results of the study showed that the implementation of a ban on plastic carrier bags increase the environmental impact of the purchase of carrier bags in Utrecht. Therefore, a sensitivity analysis was performed to examine the effect that different assumption made in the study would have on the results. Additionally, it was examined what the effect would be of implementing reuse of carrier bag on the results.

Decrease in purchase of carrier bags

First, it was calculated how much the purchase of carrier bags should additionally decrease to reach the same level of environmental impact, expressed in shadow costs, as in the current situation. For this calculation, the distribution of the different bags in the scenarios was kept equal to the survey results. The results are shown in Figure 25.

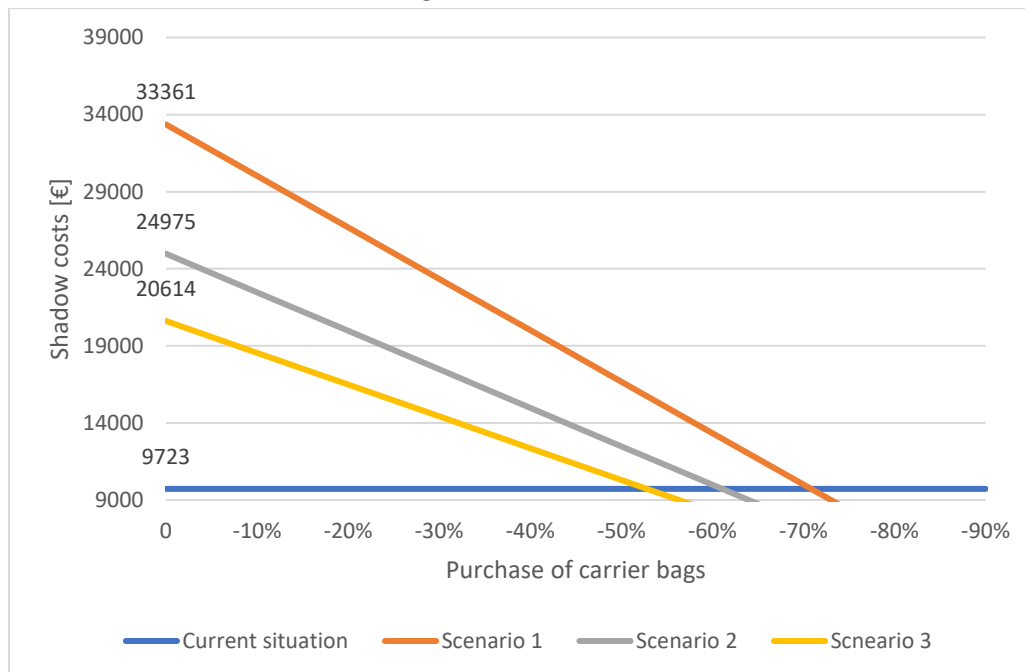


Figure 25: The required additional decrease of purchase of carrier bags to reach the same environmental impact as the current situation. The blue line represents the level of the current situation. X-axis represents the additional reduction.

In the figure the x-axis represents the additional percentual decrease of carrier bags required in the scenario situations. The blue line represents the shadow costs of the current situation. When solely considering the purchase of carrier bags, a decrease of 71% would be required in scenario 1 to reach the same level of environmental impact as the current situation. This amounts to a total decrease of 74% in scenario 1, compared to the current situation. While the expected reduction of bags is 10% according to the survey results. For scenario 2, an additional decrease of 61% is required. Which amounts to a decrease of 68% compared to the current situation, the survey results expected a decrease of 19%. Lastly, scenario 3 required an additional reduction of 53%. This a decrease of 68% compared to the current situation, while survey results expected a decrease of 31%. When there is a decrease of 68% in the number of bags purchased, still 363574 carrier bags are purchased each month. This comes down to approximately 1 carrier bag (considered for multiple use) per person each month.

Decrease of purchase of carrier bags in the supermarket

The supermarket has the highest environmental impact, expressed in shadow costs (68% of the total in scenario 3). Therefore, it was examined how much the purchase of carrier bags needs to decrease supermarkets to reach the same level of environmental impact as the current situation.

The results are shown in Figure 26.

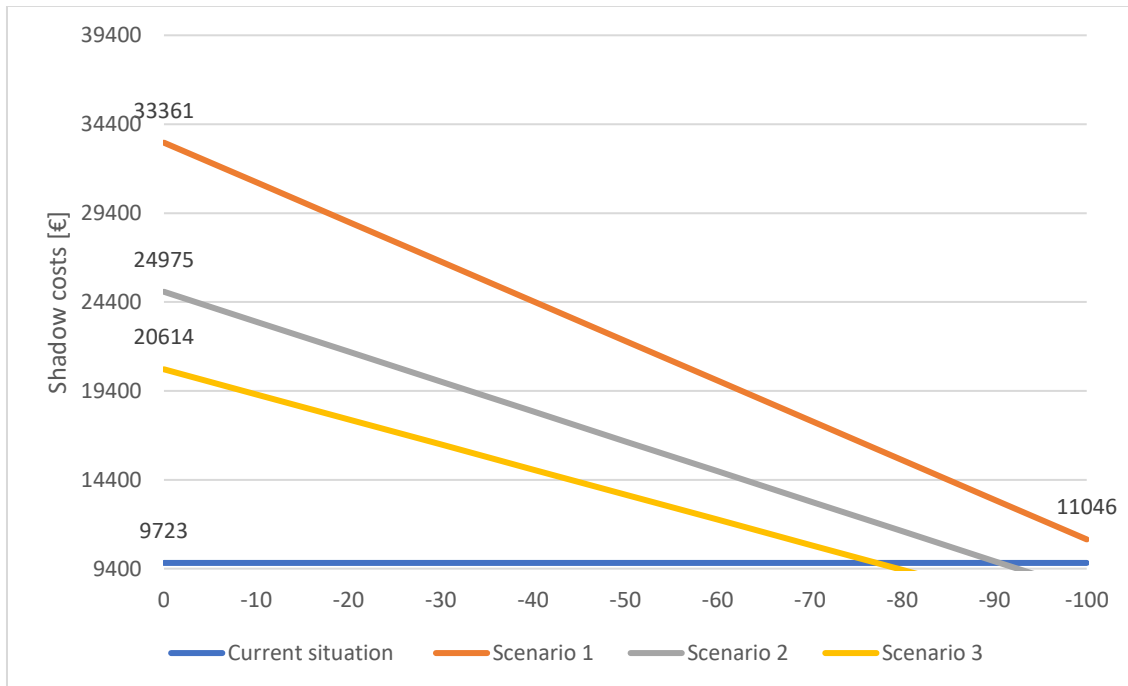


Figure 26: The required additional decrease of purchase of carrier bags in the supermarket to reach the same environmental impact as the current situation. The blue line represents the level of the current situation.

For scenario 1 similar shadow costs as the current situation cannot be reached by not purchasing carrier bags in the supermarket. For scenario 2 an additional reduction of 91% is required to reach the same shadow costs as the current situations. This amounts to a total decrease of 92% in the supermarket compared to the current situation. The survey results expected a decrease of 13% of the purchase of carrier bag in the supermarket for scenario 2. For scenario 3 and additional reduction of 77% is required, this amounts to a total decrease of 83% compared to the current situation. A reduction of 26% was expected by the survey results. Although the supermarket has shown to be the largest contributor of the environmental impact of the different stores. These results show that if a ban on plastic carrier bags is implemented, consumers behaviour should not only change in the supermarket, but in all store types.

Replacing the PP non-woven by a PET bag

It was also examined the effect of not considering the PP non-woven in the study. In the scenarios, PP non-woven was the most purchased bags. A possible explanation for this is because it was the cheapest bag available in supermarkets and in scenario 3. However, the PP non-woven is not the most environmentally friendly bag in terms of the shadow costs, but is in 5th place (Appendix D: Shadow costs of different bags). Therefore, it was checked what the effect would be if the PP non-woven was replaced by the most environmentally friendly bag considered for multiple uses, which is the PET bag. The results are shown in Table 26. Although the shadow costs decrease by this replacement, the

environmental impacts of the scenarios are still higher than the current situation (217.8% increase for scenario 1 and 71.0% increase for scenario 3).

Table 26: Sensitivity analysis when the PP non-woven bags are replaced by the PET bags. The percentual change shows the effect on the shadow costs.

	Shadow costs [€]	Percentual change
Current situation	9497	-2.3%
Scenario 1	30183	-9.05%
Scenario 2	21402	-14.3%
Scenario 3	16243	-21.2%

Considering paper bags in the supermarket

Another assumption in the study was that paper bags were not considered in the supermarket. If the paper bags would have been considered in the supermarket, the paper bag would have been the cheapest option in scenario 1 and 2. Therefore, it was also examined what the effect would be if the paper bags were offered in the supermarket. For this, it was chosen to replace all PP non-woven bags in the supermarket by a paper bag. The replacement was not performed in the current situation since the paper would not have been the cheapest option in the current situation. The results are shown in Table 27.

Table 27: Sensitivity analysis if paper bags were considered in the supermarket. The PP non-woven bags in the supermarket were replaced by paper bags. The percentual change shows the effect on the shadow costs.

	Shadow costs [€]	Percentual change
Current situation	9723	0%
Scenario 1	34679	+3.9%
Scenario 2	27674	+10.8%
Scenario 3	20614	0%

Since the paper bags have a higher shadow cost than the PP non-woven, the shadow costs increase more in scenario 1 and 2. In Scenario 3, it stays the same since paper bags were not considered there.

Considering reuse of carrier bags

One big assumption made in this study is that only the purchase of new carrier bags was considered in the functional unit. Reuse of the bags was not considered, although this would have a big effect on the results. Therefore, the effect of re-using the carrier bags was determined. For this calculation, the amount of times of reuse as determined in the survey was used (Section 4.2). This was calculated for the median values of reuse the carrier bags. Results are shown in Figure 27 and Figure 28. For this calculation, reusing was also considered in the current situation. It should be kept in mind that, by implementing the reuse of bags in the results with this method, it means that each bag purchased should be used the amount of times calculated in Section 4.2.

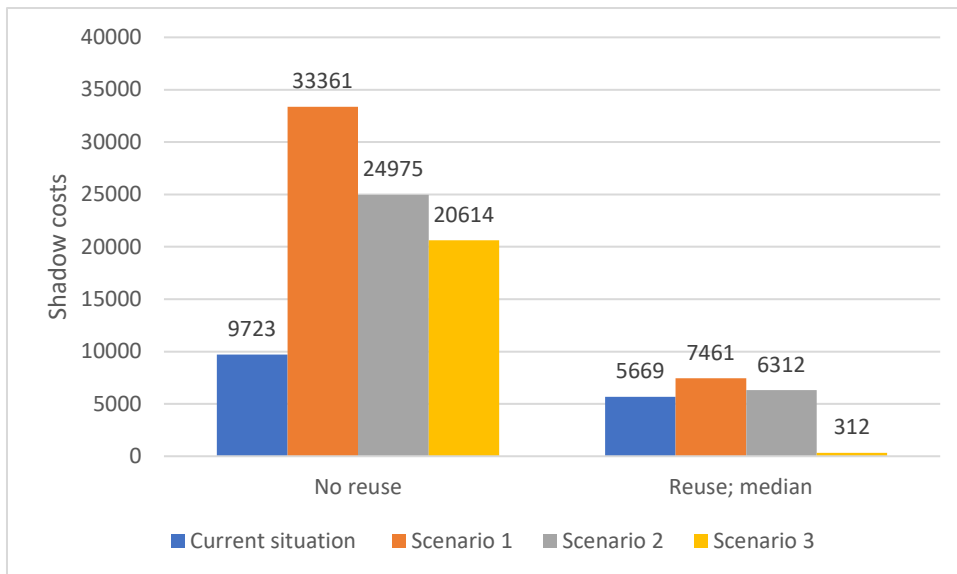


Figure 27: Shadow costs of the different scenarios. With and without implementation of reuse of carrier bags.

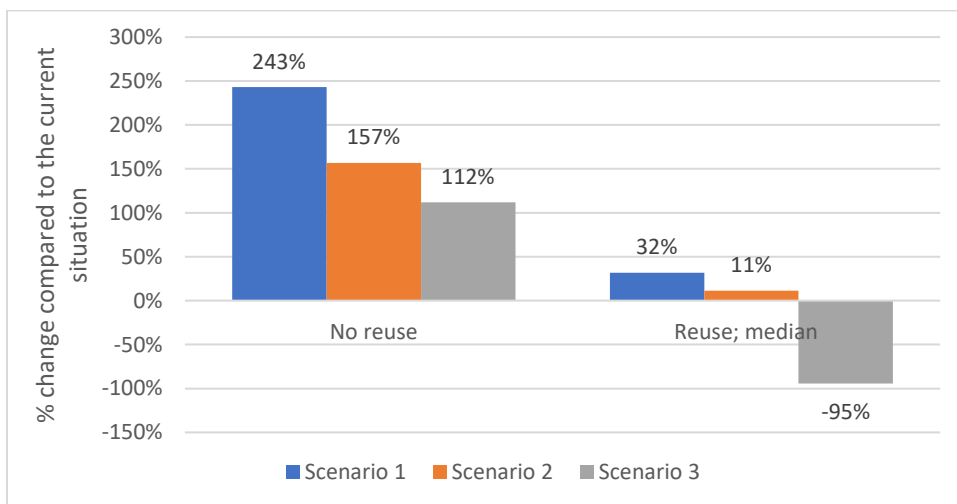


Figure 28: Percentual change of the shadow costs compared to the current situation. Results are shown when no reuse of the carrier bags is considered, and when the reuse by the median value is implemented.

The results are shown in shadow costs and the percentual change compared to the current situation. Implementing reuse of the bags has a significant influence on the results. The results show that with the implementation of reuse in the results, the environmental impact of scenario 3 is 95% lower than the current situation. This is because the environmental impact of each bag is divided by the amount of times of reuse. The HDPE and paper bags are considered for single use, thus the environmental impact stays equal. While, for the cotton bag the amount of times of reuse is 100. Therefore, the environmental impact of the cotton bag decreases with a factor 100. Since in scenario 3 only bags are considered for multiple use, the environmental impact of this scenario declines significantly and becomes lower than the current situation. While in scenario 1 and 2, the single use paper bags highly effect the results which lead to a high environmental impact.

6. Discussion

The discussion consists of several parts. First the use of a survey for data collection is validated. Next, the use of the theory of planned behaviour as a predictor for future behaviour is discussed. Then, the assumptions made in this study are reviewed. Also, the reliability of the results are discussed. Lastly, recommendations are made for further research and for the implementation of a ban on plastic carrier bags.

Use of survey data

Although, the idea of using a survey to conduct a study that examines consumers behaviour is relatively simple and widely used (Biemer & Lyberg, 2003), there are some difficulties when looking at the reliability of the survey data collected.

Survey research is very error prone. Potential errors may exist from sampling errors, the sampling process, question bias, question wording, non-response bias etc. (Stray, 2009). The non-sampling errors (due to errors in the response) have a bigger effect than sampling errors (by expanding the responses to give an estimation) (Assael & Keon, 1982). Non-sampling errors can occur for a variety of reasons. Firstly, it is challenging for respondents to reconstruct opinions, perceptions or representations that cannot easily be compared to an objective state (Mercklé, Octobre & Jacobs-Colas, 2015). Secondly, when respondents lack memory of a certain event they are questioned about, answers to the questions could be “invented”. The respondents are then inclined to answer in a way that seems socially desirable (according to them). Also, the type of questions and the way questions are formulated could lead to respondents answering in a certain direction. Which could mean that the respondents (un)intentionally provide unreliable data (Scheaffer, Mendenhall & Ott, 1990). Again, because respondents presumably answer as if they show better behaviour than what their actual behaviour is (Mercklé et al., 2015). The survey used in this study could be influenced by this behaviour since the questions used could give participants the feeling that bringing your own carrier bag is desirable.

Unfortunately, there is no methodology to measure the response errors for the survey used in this study, since the survey required imagination for future situations and behaviours. Non-sampling errors can be detected by looking at the “inconsistent” answers between the questions regarding the amount of times respondents forget to bring their own bag in the different scenarios (as stated in Section 4.2). The amount of inconsistent answers varied between 35 (8%) for the supermarkets and 95 (21.7%) for the food retail. The higher number in food-retail can be explained because, as the survey results show, the supermarket is the store where respondents shop most often. Therefore, the respondents could better imagine their future behaviour in terms of use of carrier bags. Next to this, a substantial number (50.4% for the supermarket) of the respondents answered that they never forget to bring their own bag. Which seems a very high number. There are some methodologies suggesting how to deal with inconsistent answers, such as “removing all inconsistent answers” or “first response is the most accurate” (Mercklé et al., 2015). But it was decided not to implement these methods since this type of adjustments highly influences the survey results. Therefore, this survey could be prone to the beforementioned non-sampling errors. Where the amount of times that people forget to bring their own bags could be underestimated, which would lead to higher impacts than reported.

In total 437 respondents participated in the survey. According to De Leeuw, Hox and Dillman (2012), a confidence level of 95% is typically used to minimize sampling errors in surveys. To stay within a 5% confidence interval of this confidence level, 384 participants would be required to represent the population. This number of participants was therefore achieved. The majority of the respondents were female and between the age of 15 and 35. Females are typically more likely to participate in a survey than males (Smith, 2008), also this age category is the largest population in the city of Utrecht (WistUdata, 2020).

Use of theory of planned behaviour

Another assumption made in this study, is that the theory of planned behaviour was followed by using the survey respondents' intentions as the predictor of future behaviour in terms of their carrier bag use. Although a large number of studies have proved that using the theory of planned behaviour, and therefore intention, as a predictor of future behaviour is an effective theory (Hassan et al., 2016). Nevertheless, the use of this theory is also questioned. Not only because the theory of planned behaviour is fully mediated by people's intention, but it is also mentioned that the theory of planned behaviour neglects objective situational constraints and facilitators as well as habits and personal norms (Klößner & Blöbaum, 2010). Next to this, there is a lack in understanding of the gap between intention and behaviour (Hassan, Shiu and Shaw, 2016). Even though understanding this gap is important to researchers, only a few studies measure the actual behaviour as a variable in a study based on the theory of planned behaviour (Armitage & Conner, 2001). Contradicting results have been shown, for example, in the study by Hassan and colleagues (2016) the gap between intention and behaviour in terms of ethical consumption was investigated. The study suggested that there was a large gap between participant intention and behaviour. On the other hand, in the study by Nigbur, Lyons and Uzzell (2010), where participation in a kerbside recycling program was measured. An expanded theory of planned behaviour was used, and the results showed that the intention of participating in a kerbside recycling programme did predict behaviour.

There is no clear reason why intentions do predict behaviour in one situation but will not in another. Whether using people's intentions, in terms of their carrier bag use, is a valid method to predict behaviour can only be determined by expanding the study with observational measures (which is impossible in the case of scenario situations).

Since respondents in the survey, were forced to make a decision between the different options of bags, it can be assumed that the choice of the bag used is valid for behaviour. Since it is less likely to show "desired behaviour". Therefore, the shift between scenario 2 and 3, where respondents choose the option "another option" more often than "purchasing a bag", can also be assumed to predict future behaviour. It is more difficult to predict whether people will show improvement in how often they forget to bring their own bag.

Combining the use of a survey and the theory of planned behaviour could make the study very error prone. On the other hand, the number of plastic bags found in the current situation was very close to the value found by the study of I&O research (2020). While, these errors also occur in the survey questions of the current situation. Since, in this study the scenario situations are very often compared with the current situation, the change in behaviour might be more reliable than the actual values found.

Assumptions in the survey

In this study, survey results were used to predict carrier bag use in different scenarios. Simplified situations were presented to the respondents in the survey. By simplifying the situations, the validity to use the survey results as the predictor of current and future scenarios behaviour is influenced. First, only 4 store types were used to represent the use of carrier bags. Although these store types were selected based on the most frequent stores, more store types exist which were not included in the study.

Next to this, also the bag types offered were reduced to 8 material types in 1 size, while in stores usually bags are offered in multiple sizes. Also, in the survey questions, respondents always had the option to choose between 8 different types of carrier bags (7 for the supermarket, this decreases for all stores in the scenarios). These 8 bags were average bags from different materials. In a real situation, a store usually only offers 2 to 3 types of carrier bags at the cash register. In real life consumers have therefore less options of carrier bags they can choose compared to the study. However, by giving the participant of the survey the option of all the bags available, the result does show what type of bag consumers prefer when they had all the options to choose from.

This had a substantial impact on the amount of times the PP non-woven bag was chosen as an option. This bag was the cheapest option found in the field research, and therefore also in the survey. Hence, this bag was often chosen as the option when people forget to bring their own bag to a store. While, the field research showed that every type of store offered this bag at least once, it was not offered in every store. Additionally, although the pp non-woven was the cheapest option, it was not the bag with the lowest shadow costs (of the bags considered for multiple use) which was the PET bag. The sensitivity analysis showed that when the PP non-woven was replaced by the PET, it showed to decrease the value by 21% in scenario 2.

Moreover, in this study it was decided not to offer paper bags as an option in the supermarket, therefore again the PP non-woven was chosen very often for the scenarios in the supermarket since it was the cheapest option. The sensitivity analysis showed, that by not considering the paper bag in supermarket, the results would be underestimated since paper bags had higher shadow costs than the PP non-woven.

Assumptions in the study

The biggest assumption made in this study is that the functional unit of the study was *“Carrying of purchased goods from supermarkets, food-retail, clothing and department stores, by consumers in the city of Utrecht to their home, over the period of one month”* which was based on the purchase of new bags. The answers of the survey were used to calculate how many new bags would be purchased by the respondents over different scenarios in a specific period of time. This calculation was made based on the number of times that respondents would forget to bring their own bag from home, and therefore would buy one in the store. This purchase of bags in the future scenarios is the factor that was compared to the current situation. Which showed that people predict to purchase less bags in the different scenarios. Implementation of reusing carrier bags showed to have a considerable influence on the results. The sensitivity analysis showed that in scenario 3 the environmental impact decreased by 95% over the current situation by implementing reuse of the carrier bags. It should be kept in mind

that the way reusing bags was implemented meant that all the bags purchased should be reused the amount of times stated by the respondents of the survey.

Only 8 out of 437 respondents indicated that they do not have a reusable bag at home. But still in the current situation over 1 million carrier bags are purchased in the city of Utrecht. These bags are also produced and will be disposed at some point; therefore, it was decided to take the purchase as the base for the functional unit. It could be possible that people use all their carrier bags until they are completely broken and can be disposed, but in between, other bags are bought as well since you simply forget to bring your own bag and a carrier bag is still required.

Therefore, this study gave new insights. Usually LCA studies are performed where different products are compared to fulfil the same functional unit (1 type of product fulfil the complete functional unit). But for this study it was decided to examine it from the consumers behaviour perspective, by comparing (in different situations) what the impact is from the purchase of carrier bags by consumers. Since the production of carrier bags (which is driven by this consumption) determines the actual environmental impact.

There are some other points that need to be considered in the calculation of the number of purchased bags in Utrecht and the LCA calculations. First of all, the study performed by Boukris et al. (2015) was taken as the only source of the LCA data. Their study did not have a value for the PP non-woven bag and therefore a conversion factor of 1.15 was taken between the PP woven and PP non-woven, based on the study by Bisinella et al. (2018). Also, it was assumed that most of the bags were made of virgin materials, only for the paper bags 75% recycled material was implemented. While, most of the materials consist for some part of recycled material. By implementing more recycled material, the environmental impact decreases. Next to this, the survey results were expanded to the inhabitants of Utrecht, while more people go shopping in Utrecht. Lastly, the survey results showed that 60% of the plastic carrier bags are reused as a garbage bag. Therefore, an implementation of a ban on plastic carrier bags might lead to an increase in purchase of garbage bags.

Littering potential

In this thesis, also the littering potential for the different scenarios was determined. These values should be taken with caution since the littering potential was a new suggested way of comparing different bags. Next to this, not all values required for the calculation of the littering potential were exactly known. This problem was avoided by using different values for the unknown ones and looking at the effect on the ranking of the littering potential. Additionally, a littering value was introduced to enable to compare the different scenario situations to the current situation. Since the Littering potential was not exactly known for all bag types, this littering value was assumed equal for the bags that had a variable ranking in the calculation of the littering potential. This littering value was only an invented value, and should therefore be taken with caution.

Comparison of results

Although the study has shown to be error prone through the use of a survey and the many assumptions that were implemented, the results found in the current situation are similar to a recently published study by I&O research (2020). In the study by I&O Research it was estimated that 35 plastic carrier

bags are consumed per person in The Netherlands. The results of this study showed 33.97 bags are consumed.

Additionally, in the study by I&O Research (2020), it was stated that the implementation of a levy on plastic carrier bags reduced the purchase by 80%. Although the exact numbers are not exactly known, CE Delft (2016) predicted that between 10 and 25% percent of these plastic bags were replaced by a paper bag. This shows that making consumers pay for a carrier bag, highly influences the purchase. It was stated that there was also an increase of other types of carrier bags (such as PET and cotton), but no numbers for these bags were listed. Since the study by I&O Research did not provide data on all types of carrier bags it is impossible to compare the results. On the other hand, the study by CE Delft (2016) gives an indication of the rebound effect that could be expected. This rebound effect predicted by CE Delft (2016) is lower than found in this study. In this study only a total decrease of 31% was found for the purchase of all carrier bags (when plastic and paper bags are banned). While, 93% of the total purchase of carrier bags consist of plastic and paper bags. This would amount to a rebound effect of 62%.

When looking at the impact that the levy had on consumption of carrier bags, it seems unrealistic to assume that when plastic and paper bags are not offered for free anymore, this would only lead to a reduction between 19% and 31% of the purchased carrier bags (as found with the implementation of scenario 2 and 3). It's more likely that the decrease will be higher, although a transition phase in which the purchase of bags decrease with time can be assumed. On the other hand, almost all respondents said to have carrier bags at home that are considered for multiple use, but also in the current situation a high number of carrier bags are purchased.

From the sensitivity analysis, it was showed that for scenario 2 and 3 a reduction of 68% of the carrier bags would be required to reach the same monthly environmental impact as in the current situation. This would amount to 1 bag (considered for multiple use) per person each month. Whether this is an unreal high decrease, is hard to tell since there is no data to compare with.

6.1 Further research

One big difficulty in this study is that there is a limited amount of data available about current carrier bag use. A new report was presented by I&O Research (2020) in which the current use of plastic carrier bags is examined. But still no data is available on the purchase of other carrier bags made from materials such as PET or cotton. If data on the purchase of these bags would be available, the actual use of the carrier bags could be better determined next to the impact of carrier bags.

This study showed that if a ban on all carrier bags considered for single use would be implemented (scenario 3), a decrease of 68% would be required in the purchase of carrier bags to reach similar environmental impact as the current situation. By having more accurate data on the purchase of carrier bags, also this decrease could be better determined and would show whether this 68% decrease is realistic. Additionally, it would be good to model how a transition phase of implementing a ban on plastic bags would look like. For example, by making scenarios in which the transition phase takes different amounts of time, and what the impact of that would be.

6.2 Recommendations

Based on the results of this study, and from previous studies, the following recommendation can be given for considering the implementation of a ban on plastic carrier bags.

First, it has been shown that by introducing a ban on plastic carrier bags, in any form, the environmental impacts of using carrying bags could increase. On the other hand, littering as a result of carrier bags could decrease. Therefore, it is important to determine which of the two factors a municipality considers to be the most important. And which impact a municipality want to reduce.

When it is chosen to implement a ban on plastic carrier bags, it is recommended to implement a ban for all carrier bags considered for single use, and therefore paper bags as well. The implementation of such a legislation has shown to have the lowest increase in environmental impact and highest reduction in litter.

When a ban is only implemented on plastic carrier bags and not on single use paper bags, consumers behaviour is affected, but still the option of a free paper bag is easily chosen. As paper bags have shown to have high environmental impact, this is not recommended.

Additionally, it was shown that a pricing mechanism highly effects the purchase of carrier bags. Again, when implementing a pricing mechanism, this should be implemented on all carrier bags. As long as carrier bags are still offered free of charge this will lead to higher consumption than required. Resistance from consumers in the implementation of such a ban can be expected to be relatively low. But it is important to always implement such a legislation with good campaigning.

Also, survey respondents gave some alternative ideas on how to reduce the purchase of carrier bags. Respondents stated that even simple measures such as changing the placements of bags in the store could already have an effect for them.

Although it is not showed in this thesis. Wallonia (Belgium) is an example where a ban on plastic carrier bags has been implemented. This ban was gradually implemented since December 2016. Personal communication with Anne-Florence Taminiaux from the public services of Wallonia (added in Appendix Q: Interview Public service of Wallonia) has shown some important point that should be considered. In Wallonia, the implementation of the ban took 2 years in which several campaigns were launched to inform various publics. Unfortunately, there is no data on the effectiveness of the ban yet, but consumers and merchants accepted the ban as long as they were well informed. Resistance also occurred, mainly from the distribution and petrochemical sectors. Since this occurred, compromises had to be made with this sector. Resistance from this sector was earlier found in America, where a "Progressive bag alliance" was founded who represents a number of major single-use plastic bag manufacturers (Farsi & Hansen, 2016). This alliance, lobbies against implementation of introduction of fees and bans of plastic bags. Therefore, such resistance can be expected if a ban on plastic carrier bags is implemented.

7. Conclusion

In the thesis and attempt was made to answer the following research question *“What would be the environmental consequences of banning all plastic carrier bags in the city of Utrecht?”*

This research was performed by several steps. The first sub-question was *“What is the current situation in the city of Utrecht, in terms of plastic bag consumption and consumption of alternative bags?”*

Four store types (Supermarket, food-retail, clothing store and department store) were selected as the main sources where carrier bags were purchased. By conducting the field research, an inventory was made of the types of bags that were offered in the different stores. From this field research, 8 bag types, with an average price, were chosen as the base of the research.

By distributing a survey among consumers and inhabitants of the city of Utrecht, an average purchase of 3.88 carrier bags per person per month was determined. Of these 3.88 bags, 2.83 bags (73%) are plastic carrier bags. Most of the carrier bags are purchased in the supermarket. Inhabitants of the city of Utrecht bring their own bag between 66% of the time to a clothing store and 86% of the time to the supermarket.

Additionally, the survey results gave some insights on consumers behaviour with regard to carrier bags use. Such as, the main reason why consumers buy a carrier bag is because they forget to bring a carrier bag. Additionally, only 8 out of 437 respondents reported not having bags considered for multiple use at home, showing that people have the means to bring their own bag to a store.

The bags that are most often purchased, next to the plastic bags, are the paper bags with 0.8 bags (20%) each month per person. The social-demographic characteristic gender and age have shown to have great influence on people's consumption of carrier bags. For example, over 80% of the carrier bags are purchased by consumers between the age 15 - 45.

The second sub-question was *“How would consumers' behaviour change in Utrecht when banning plastic carrier bags, in three scenarios?”*

By using the results of the survey, in which the respondents were now confronted with different ban scenarios, it was determined how consumer's use of carrier bags would change with the implementation of different legislation concerning plastic carrier bags. The respondent's intentions, as stated in the theory of planned behaviour, was used as the predictor of future behaviour.

Results showed that consumers in the city of Utrecht bring their own bag between 88% - 89% of the time to the supermarket in the ban scenarios. Reduction of the purchase of carrier bags was largest in the clothing store for all scenarios, this reduction was 53% when the strictest scenario (3) was implemented. Overall, the number of bags purchased decrease between 10% - 31% for the different ban scenarios. Since plastic bags are not offered in any of the ban scenarios, (and neither paper bags in scenario 3), these bags are replaced by other types of carrier bags. The most chosen alternative is the PP non-woven, which is also the cheapest option available.

The last sub-question was *“How do the three scenarios compare to the current situation from an environmental perspective?”*

When the change in purchase of carrier bags is used to estimate the environmental impact of carrier bags, the decrease in purchase of bags does not outweigh the increase in the environmental impact.

This is because, after the implementation of a ban on plastic bags, these bags are replaced by carrier bags with a higher environmental impact. By implementing a ban on plastic bags, this led to an increase in the environmental impact (expressed in shadow costs) between 112% (scenario 3) and 243% (scenario 1). Contrary, littering of carrier bags does seem to highly decrease by implementing a ban on plastic carrier bags. It was estimated that the littering of carrier bags decreases between 37% (scenario 1) and 50% (scenario 3).

By decreasing the purchase of carrier bags with 68% compared to the current situation, the environmental impact of the ban scenarios will be equal as the current situation. This amounts to the purchase of 1 carrier bag (considered for multiple use) per person each month.

In conclusion, the results found in the study should be taken with caution. For example, reuse of the carrier bags was not considered in the study but purchase of the carrier bags was taken as the guideline. This was done because the production of carrier bags determines the environmental impact, and this production is driven by consumption. When re-using of carrier bags is implemented, this has shown to highly effect the results and even showed an improvement of the environmental impact by 95% for scenario 3. Scenario 1 and 2 still showed a deterioration of the environmental impact. Additionally, the littering potential was a suggested way of comparing different bags and therefore scenarios, which gave the insight that littering of carrier bags would decrease if a ban on plastic carrier bags is implemented.

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Appendix A: Survey

Dear participant,

Thank you very much for participating in the research about the use of (plastic) carrier bags. In this anonymous survey, several questions will be asked about your current use of carrier bags in different types of stores. This survey consists of 39 questions and taking part will take no longer than 10 minutes.

By participating on this survey, you will help to understand the effect that a total ban of plastic bags may have in the city of Utrecht. This research is conducted by the University of Utrecht.

May you have any questions left, you can always send me an e-mail at s.f.deleeuw@students.uu.nl

Kind regards,

Selma de Leeuw

I agree to anonymously participate in the research study. I understand the purpose and nature of this study and I am participating voluntarily. I understand that I can withdraw from the study at any time, without any penalty or consequences.

- Yes
- No

I grant permission for the data generated from this survey to be used in the researcher's publication on this topic.

- Yes
- No

General information

Q1. What is your age? (in Years)

Q2. With what gender do you identify? (Choose 1 option)

- Male
- Female
- Neither

Q3. What kind of region do you live in? (Choose 1 option)

- Rural
- Suburban
- Urban

Q4. Do you live in the city of Utrecht? (Choose 1 option)

- Yes
- No

Q5. Do you sometimes go shopping in the city of Utrecht? (Choose 1 option)

- Yes
- No

Q6. What is the highest degree or level of school you have completed? (Choose 1 option)

- Less than a high school diploma
- High school degree
- Some college, no degree
- Associate degree
- Bachelor's degree
- Master's degree or higher

Current situation

Q7. Which types of bags do you have at home? (Multiple answers possible)



Thin Plastic



Thicker plastic



Paper



Fabric Shopper



Plastic Shopper



Foldable plastic



Jute



Cotton

Q8. In which store do you get or buy a bag most often? (Choose 1 option)

- Supermarket
- Food-retail (e.g. butchers, bakers and greengrocers)
- Clothing store
- Department store
- Others option, namely _____

Q9. Since 2016 it is not allowed to distribute plastic bags free of charge. Do you feel that the introduction of a tax on single-use plastic carrier bags has made you more aware of your current plastic consumption? (Choose 1 option)

- Yes
- No

explanation:

Q10. What do you do with your plastic carrier bags after using them? (Multiple answers possible)

- Reuse them as a carrier bag
- Use them as a garbage bag
- Dispose them together with the general waste
- Dispose them into the plastic container
- Other option, namely: _____

Q11. If you reuse a bag, how often do you reuse the bags before disposing them? (Write in each box an approximate amount of times.)

			
Thin Plastic <input type="checkbox"/>	Thicker plastic <input type="checkbox"/>	Paper <input type="checkbox"/>	Fabric Shopper <input type="checkbox"/>
			
Plastic Shopper <input type="checkbox"/>	Foldable plastic <input type="checkbox"/>	Jute <input type="checkbox"/>	Cotton <input type="checkbox"/>

Q12. How often do you go to the following stores? (Give your answer in approximate times a month)

Supermarket	Food-retail (e.g. bakers, butchers, greengrocers etc.)	Clothing store	Department store (Including stores such as Hema and Action)
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Q13. When you go to the following stores, which type of bag do you usually use or buy? (Choose 1 option per store, not all options are available in each store)

	Supermarket	Food-Retail	Clothing store	Department store
Buy at least one thin plastic bag (Price €0,05)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy at least one thicker plastic bag (Price €0,20)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Take a free paper bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option, or a combination of bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q14. How many of the bags chosen in the previous question do you need each time that you go to these stores? (Give your answer in an average number of bags)

Supermarket	Food-retail	Clothing store	Department store
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Q15. If you chose to bring your own bag which type of bag do you usually use?

Q16. If you chose another option or a combination of bags, could you specify what is it?

Q17. How often do you forget to bring your own bag to a store? (Choose 1 option per store)

	<i>Supermarket</i>	<i>Food-Retail</i>	<i>Clothing store</i>	<i>Department store</i>
Never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Less than half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More than half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I never bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q18. If you forget to bring your own bag, which option would you choose? (Choose 1 option per store, not all options are available in each store)

	<i>Supermarket</i>	<i>Food-retail</i>	<i>Clothing store</i>	<i>Department store</i>
Buy a thin plastic bag (Price €0,05)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a thicker plastic bag (Price €0,20)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Take a paper bag (Free of charge)		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a fabric shopper (Price €1,00)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a plastic shopper (Price €1,60)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a foldable plastic bag (Price €1,80)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a jute bag (Price €2,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a cotton bag (Price €3,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q19. If you chose "other option", could you specify what it is?

Scenario 1. Imagine that the municipality of Utrecht is banning the use of plastic bags to reduce plastic production and answer the following questions accordingly. Note that in this scenario the choice of bag has changed (plastic ones are not allowed).

Q20. Considering that single-use plastic bags are not available, which types of bag would you use? (Choose 1 option per store)

	Supermarket	Food-retail	Clothing store	Department store
Take a free paper bag		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy the cheapest option available	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option, or a combination of bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q21. If you chose "other option or a combination of bags, could you specify what it is?"

Q22. How often do you think you would forget to bring your own bag to a store in this scenario? (Choose 1 option per store)

	Supermarket	Food-Retail	Clothing store	Department store
Never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Less than half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More than half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I never bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q23. If you forget to bring your own bag in this scenario, which option would you choose? (Choose 1 option per store, not all options are available in each store)

	Supermarket	Food-retail	Clothing store	Department store
Take a paper bag (Free of charge)		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a fabric shopper (Price €1,00)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a plastic shopper (Price €1,60)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a foldable plastic bag (Price €1,80)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a jute bag (Price €2,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a cotton bag (Price €3,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q24. If you chose "other option", could you specify what it is?

Scenario 2. Imagine that the municipality of Utrecht wants to reduce the use of carrier bags even more. None of the offered bags are offered free of charge. Answer the following questions accordingly. Note that in this scenario the choice of bag has changed.

Q25. Considering this scenario, which types of bag would you use? (Choose 1 option per store)

	<i>Supermarket</i>	<i>Food-retail</i>	<i>Clothing store</i>	<i>Department store</i>
Buy the cheapest option available	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option, or a combination of bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q26. If you chose "other option or a combination of bags, could you specify what it is?"

Q27. How often do you think you would forget to bring your own bag to a store in this scenario? (Choose 1 option per store)

	<i>Supermarket</i>	<i>Food-Retail</i>	<i>Clothing store</i>	<i>Department store</i>
Never	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Less than half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More than half of the time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I never bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q28. If you forget to bring your own bag in this scenario, which option would you choose? (Choose 1 option per store, not all options are available in each store)

	<i>Supermarket</i>	<i>Food-retail</i>	<i>Clothing store</i>	<i>Department store</i>
Buy a paper bag (Price €0,20)		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a fabric shopper (Price €1,00)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a plastic shopper (Price €1,60)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a foldable plastic bag (Price €1,80)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a jute bag (Price €2,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a cotton bag (Price €3,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q29. If you chose "other option", could you specify what it is?

Scenario 3. *Imagine that the municipality takes it even one step further. And that in this case no single-use bags are offered at all. Answer the following questions accordingly. Note that in this scenario the choice of bag has changed (plastic and paper bags are not allowed).*

Q30. Considering this scenario, which types of bag would you use? (Choose 1 option per store)

	Supermarket	Food-retail	Clothing store	Department store
Buy the cheapest option available	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I bring my own bag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option, or a combination of bags	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q31. If you chose "other option or a combination of bags, could you specify what it is?"

Q32. If you forget to bring your own bag in this scenario, which option would you choose? (Choose 1 option per store, not all options are available in each store)

	Supermarket	Food-retail	Clothing store	Department store
Buy a fabric shopper (Price €1,00)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a plastic shopper (Price €1,60)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a foldable plastic bag (Price €1,80)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a jute bag (Price €2,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Buy a cotton bag (Price €3,40)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other option	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q33. If you chose "other option", could you specify what it is?

Last questions

Q34. Do you think that a ban on plastic bags in Utrecht is a good idea? (Choose 1 option)

- Very good
- Good
- Neutral
- Bad
- Very Bad

Explanation:

Q35. Which one of the three scenarios do you prefer? (Choose 1 option)

- Current situation
- Scenario 1; Plastic bags will be banned.
- Scenario 2; Plastic bags are banned, and no bags are distributed free of charge.
- Scenario 3; Plastic bags are banned, and no single-use bags are available.

Q36. Why would you not bring your own bag to a store? (for example, I want new bought clothes to be in a clean bag, protection of food.)

Q37. Why would you bring your own bag to a store?

Q38. Do you have another idea of how the use of plastic carrier bags could be reduced (other than with a ban)?

Q39. Any last remarks you would like to share?

Appendix B: Environmental impact of carrier bags

The table shows single use cradle to grave impact categories for different carrier bags. Updated version from Boukris et al. (2015).

	Climate change	Ozone depletion	Terrestrial acidification	Freshwater eutrophication	Marine eutrophication	Human toxicity	Terrestrial ecotoxicity	Agricultural land occupation	Urban land occupation	Water depletion
	Kg CO ₂ -eq	Kg CFC 11 eq.	Kg SO ₂ -eq	Kg P-eq	Kg N-eq.	Kg 1,4-DCB-eq.	Kg SO ₂ -eq.	m ² a	m ² a	m ³
HDPE Small	2.35E-02	-3.11E-10	1.29E-04	9.08E-07	3.79E-06	2.88E-03	9.93E-07	2.20E-04	8.92E-05	1.80E-05
LDPE medium	1.21E-01	-1.03E-09	5.83E-04	8.29E-06	1.74E-05	1.77E-02	6.09E-06	1.92E-03	4.41E-04	9.51E-05
Paper medium	9.78E-02	5.03E-09	9.86E-04	3.01E-05	6.05E-05	2.83E-02	1.34E-05	4.45E-01	4.95E-03	3.85E-03
Paper medium recycled material	2.23E-02	1.33E-09	1.59E-04	1.13E-05	1.80E-05	1.12E-02	7.97E-06	1.19E-01	1.33E-03	1.07E-03
PP non-woven big shopper	4.82E-01	-5.45E-09	2.15E-03	2.33E-06	7.32E-05	2.99E-02	6.06E-07	2.67E-03	9.10E-04	2.28E-04
PP big shopper	4.19E-01	-4.74E-09	1.87E-03	2.03E-06	6.37E-05	2.60E-02	5.27E-07	2.32E-03	7.91E-04	1.99E-04
PET medium	1.62E-01	3.32E-09	8.34E-04	3.07E-05	3.03E-05	4.51E-02	1.68E-05	4.93E-03	1.05E-03	4.85E-04
Jute medium	8.52E-01	1.51E-08	7.71E-03	3.37E-04	8.19E-04	2.22E-01	8.15E-05	2.31E-01	8.75E-03	5.57E-02
Cotton medium	1.96E+00	7.49E-06	1.23E-02	7.20E-04	1.66E-03	6.26E-01	1.42E-02	6.44E-01	1.41E-02	1.48E-01

Appendix C: Shadow costs

Shadow price of different impact categories. Source: Boukris et al. (2015).

Impact category	Unit	Shadow price [€/ unit eq. Emission]
Climate change	Kg CO ₂ -eq	0.025
Ozone depletion	Kg CFC 11 eq.	39.1
Terrestrial acidification	Kg SO ₂ -eq	0.638
Freshwater eutrophication	Kg P-eq	1.78
Marine eutrophication	Kg N-eq.	12.5
Human toxicity	Kg 1,4-DCB-eq.	0.0206
Terrestrial ecotoxicity	Kg SO ₂ -eq	1.28
Agricultural land occupation	m ² a	0.094
Urban land occupation	m ² a	0.094
Water depletion	m ³	1

Appendix D: Shadow costs of different bags

The table shows the shadow costs of the different impact categories for the different type of carrier bags. The value between brackets shows the part of the shadow cost of an impact category of the total shadow costs of a carrier bag. Source: adjusted version of Boukris et al (2015). For the paper bag 75% was assumed to be recycled material. The value between brackets after the name of the bag represents the ranking of the bags according to the shadow costs with 1 the most environmentally friendly bags and 8 the least environmentally friendly bag.

Impact category	Climate change	Ozone depletion	Terrestrial acidification	Freshwater eutrophication	Marine eutrophication	Human toxicity	Terrestrial ecotoxicity	Agricultural land occupation	Urban land occupation	Water depletion	Total
Shadow price [€]											
HDPE bag (1)	5.87E-04 (71%)	-1.22E-08 (0%)	8.22E-05 (10%)	1.62E-06 (0%)	4.74E-05 (6%)	5.93E-05 (7%)	1.27E-06 (0%)	2.07E-05 (3%)	8.38E-06 (1%)	1.80E-05 (2%)	8.26E-04 (100%)
LDPE bag (2)	3.03E-03 (70%)	-4.03E-08 (0%)	3.72E-04 (9%)	1.48E-05 (0%)	2.17E-04 (5%)	3.64E-04 (8%)	7.79E-06 (0%)	1.81E-04 (4%)	4.15E-05 (1%)	9.51E-05 (2%)	4.32E-03 (100%)
Paper bags (6)	1.03E-03 (5%)	8.82E-08 (0%)	2.33E-04 (1%)	2.85E-05 (0%)	3.58E-04 (2%)	3.19E-04 (1%)	1.19E-05 (0%)	1.88E-02 (83%)	2.10E-04 (1%)	1.76E-03 (8%)	2.28E-02 (100%)
Non-woven PP (5)	1.20E-02 (78%)	-2.13E-07 (0%)	1.37E-03 (9%)	4.16E-06 (0%)	9.15E-04 (6%)	6.16E-04 (4%)	7.76E-07 (0%)	2.51E-04 (2%)	8.56E-05 (1%)	2.28E-04 (1%)	1.55E-02 (100%)
Woven PP (4)	1.05E-02 (78%)	-1.85E-07 (0%)	1.19E-03 (9%)	3.61E-06 (0%)	7.96E-04 (6%)	5.35E-04 (4%)	6.74E-07 (0%)	2.18E-04 (2%)	7.44E-05 (1%)	1.99E-04 (1%)	1.35E-02 (100%)
PET bag (3)	4.04E-03 (58%)	1.30E-07 (0%)	5.32E-04 (8%)	5.47E-05 (1%)	3.79E-04 (5%)	9.29E-04 (13%)	2.15E-05 (0%)	4.63E-04 (7%)	9.85E-05 (1%)	4.85E-04 (7%)	7.00E-03 (100%)
Textile bag; Jute (7)	2.13E-02 (18%)	5.90E-07 (0%)	4.92E-03 (4%)	6.00E-04 (1%)	1.02E-02 (9%)	4.58E-03 (4%)	1.04E-04 (0%)	2.17E-02 (18%)	8.22E-04 (1%)	5.57E-02 (46%)	1.20E-01 (100%)
Textile bag; Cotton (8)	4.89E-02 (15%)	2.93E-04 (0%)	7.85E-03 (2%)	1.28E-03 (0%)	2.08E-02 (6%)	1.29E-02 (4%)	1.82E-02 (6%)	6.06E-02 (19%)	1.33E-03 (0%)	1.48E-01 (46%)	3.20E-01 (100%)

Appendix E: List of stores in the city of Utrecht

In de buurt (2019)	Number of stores	Bezoek-Utrecht (2019)	Number of stores
Groceries	262	Clothing store	119
Clothing stores	145	Food-retail	23
Interior shop	93	Gift shop	20
Bakers	79	Jewellers	17
Supermarkets	78	Interior shop	16
Giftshops	70	Drugstore	12
Shoe stores	62	Department store	11
Jewellers	57	Book store	10
Sports stores	52	Hobby shop	6
Book stores	45	Household appliances	6
Liquor stores	43	Sports store	5
children's clothing store	39	Kitchenware shop	5
Pharmacies	36	Bicycle shop	4
Telephone store	30	Bed shop	3
Outlet stores	25	Toy store	2
Toy store	25	Music store	1
Thrift store	24		
Bicycle shop	23		
Florist	21		
Drugstores	21		
Butchers	19		
Perfumery	18		
Hardware stores	16		
Concept stores	16		
Hobby shops	16		
Candy shop	14		
Department stores	14		
Pet shop	13		
Electronics stores	13		
Fish shop	12		
Greengrocers	8		
Cheese shop	7		
Party supplies	4		
Baby store	2		

Appendix F: Extensive table of field research

	HDPE bag	LDPE bag	Paper bag	PP Non-woven	PP Woven	PET bag	Jute bag	Cotton bag
Supermarkets								
1		€ 0.40	€ 0.50		€ 1.99		€ 2.99	
2		€ 0.20			€ 0.99			
3	€ 0.10							
4	€ 0.05							
5			€ 0.25		€ 2.99	€ 1.99		€ 3.99
6		€ 0.49		€ 0.69	€ 1.39		€ 1.99	
7		€ 0.20/€ 0.30*			€ 1.85			€ 1.85
8		€ 0.50			€ 1.89			
9		€ 0.35			€ 1.69			
10		€ 0.25	€ 0.35		€ 1.45			
Food retail								
1		€ 0.10						
2	€ 0.05							
3	Free of charge							
4		€ 0.20						€ 8.95
5			Free of charge					
6		€ 0.15	€ 0.15					
7		€ 0.15						
8			Free of charge					
9			Free of charge					
10		0.1*	Free of charge*	€ 2.50				
11		€ 0.20	€ 0.25					

Clothing store	HDPE bag	LDPE bag	Paper bag	PP Non-woven	PP Woven	PET bag	Jute bag	Cotton bag
1			Free of charge					
2		Free of charge						
3			Free of charge*					
4			Free of charge*					€ 1.50
5			Free of charge					Free of charge
6			Free of charge					
7		€ 0.1*						
8			Free of charge*					
9			Free of charge*					
10			Free of charge*		€ 1.50			
11		€ 0.50		€ 0.50				
12		€ 0.05						
13		€ 0.10*	Free of charge*					
14			0.05/0.10/0.20*		€ 1.00	€ 1.50		€ 2.00
15			0.05/0.05/0.10*					
16		€ 0.10*						
17				Free of charge*				
18			Free of charge*					
19			Free of charge					
20			Free of charge					
21			Free of charge		€ 0.10			
22			Free of charge					

	HDPE bag	LDPE bag	Paper bag	PP Non-woven	PP Woven	PET bag	Jute bag	Cotton bag
Department store								
1			Free of charge*					€ 4.99/6.99*
2		€0.20/€0.30*	Free of charge		€ 1.50	€ 2.00		
3			Free of charge*					
4			Free of charge*					
5			0.35/0.40*	€ 0.75	€ 1.84			
6	€ 0.05				€ 1.49	€ 1.49		
7	€ 0.03				€ 0.58			
8		€ 0.15						
9		€ 0.15		€ 0.79	€0.69/€1.99			
10			€ 0.20					€ 3.00

*Bags are offered in different sizes

Appendix G: Statistical tests

In the tables the results from the statistical tests performed on survey questions Q12, Q13, Q14, Q17, Q18, Q34 and Q35 are shown. The first column of the table shows the results of the t-test on gender correlation. The F-values included in the table relate to results of the ANOVA tests (e.g. in Table X Q12, age category). χ^2 -values in the tables relate to Chi-square test results (e.g. in Table X Q13, age category).

The results indicated statistically significant differences in gender for question 12, 13, 17, 18, 34 and 35. This means that there is a statistically significant difference between the way males and females answered these questions, and therefore, such questions are dependent on the gender variable. For the age categories, significant differences were found in questions 12, 13, 17 and 18. And for education level, a statistically significant difference could be found for questions 17 and 34. This shows that all the socio-demographic variables have an impact on the responses of the survey questions.

When in the table a result is shown in bold, the p-value of the statistical test is below 0.05 and therefore a statistically significant difference is found between the groups.

Statistical tests performed on Q12: How often do you go to the following stores?

	Gender	Violation of homogeneity	Age categories	Violation of homogeneity	Level of education
Supermarket	t(180.1)=2.598, p= 0.010	No, $\sigma = 0.354$	F(5,427) = 1.942, p = 0.086	No, $\sigma = 0.088$	F(5,427) = 1.538, p = 0.177
Food-retail	t(388) = 1.587, p = 0.113	Yes, $\sigma = 0.006$ therefore Welch F-ratio	F(5, 121,888) = 8.36, p= 0.000	Yes, $\sigma = 0.008$ therefore Welch F-ratio	F(5, 16.975) = 1.094, p = 0.399
Clothing store	T(245.785) = - 2.935, p = 0.004	No, $\sigma = 0.229$	F(5, 409) = 1.55, p = 0.173	No, $\sigma = 0.314$	F(5,409) = 1.094, P = 0.363
Department store	T(330.318) = - 4.419, p = 0.000	Yes, $\sigma = 0.007$ therefore Welch F-ratio	F(5, 148.10) = 3.325, p = 0.007	No, $\sigma = 0.147$	F(5, 409) = 1.827, P = 0.106

Statistical tests performed on the Q13: When you go to the following stores, which type of bag do you usually use or buy?

	Gender	Age categories	Level of education
Supermarket	t(433)=1.220, p= 0.040	$\chi^2(10) = 17.626$, p = 0.062*	$\chi^2(10) = 4.246$, p = 0.936*
Food-retail	t(183.652)=-1.452, p = 0.148	$\chi^2(10) = 19.646$, p = 0.033**	$\chi^2(10) = 5.327$, p = 0.868**
Clothing store	T(190.63) = -2.675, p = 0.008	$\chi^2(20) = 27.440$, p = 0.123***	$\chi^2(20) = 19.948$, p = 0.461***
Department store	T(198.529) = -1.999, p = 0.047	$\chi^2(20) = 17.200$, p = 0.640***	$\chi^2(20) = 14.720$, p = 0.792***

* The options "Thin plastic" and "Thicker plastic" are combined.

** The options "Thin plastic" and "Thicker plastic" and the options "Own bag" and "Other option" are combined.

*** Nothing was combined, since this led to the same conclusion.

Statistical tests performed on Q14 How many of the bags chosen in the previous question do you need each time that you go to these stores?

	Gender	Violation of homogeneity	Age categories	Violation of homogeneity	Level of education
Supermarket	T(417) = -1.166, p = 0.244	No, $\sigma = 0.588$	F(5,414) = 0.899, p = 0.481	No, $\sigma = 0.561$	F(5,414) = 0.468, p = 0.800
Food-retail	T(368) = 1.084, p = 0.279	Yes, $\sigma = 0.003$ therefore Welch F-ratio.	F(5, 132.753) = 0.436, p = 0.822	Yes, $\sigma = 0.016^*$ Therefore, Welch F-ratio.	F(3, 93.125) = 0.558, p = 0.644
Clothing store	T(400) = 1.155, p = 0.249	Yes, $\sigma = 0.007$ therefore Welch F-ratio.	F(5, 148.290) = 1.498, p = 0.194	Yes, $\sigma = 0.000^*$ Therefore, Welch F-ratio.	F(3, 99.451) = 1.268, p = 0.139
Department store	T(401) = 0.221, p = 0.825	Yes, $\sigma = 0.044$ therefore Welch F-ratio.	Not enough responses in all groups to draw a conclusion	No, $\sigma = 0.093$	F(5, 398) = 0.631, p = 0.676

* Not enough responses in all groups to draw a conclusion. Therefore, the three lowest levels of education are combined.

Statistical tests performed on Q17 How often do you forget to bring your own bag to a store?

	Gender	Age categories	Level of education
Supermarket	t(192.285) = 2.217, p = 0.028	$\chi^2(10) = 19.432$, p = 0.035*	$\chi^2(10) = 23.423$, p = 0.009* When the options are converted to factors, an ANOVA test shows that there is no significant difference. F(5, 17.247) = 1.043, p = 0.424
Food-retail	t(394) = 3.823, p = 0.000	$\chi^2(10) = 15.595$, p = 0.112*	$\chi^2(12) = 12.524$, p = 0.405 Three lowest levels of education are combined
Clothing store	t(208.967) = 4.237, p = 0.000	$\chi^2(20) = 17.161$, p = 0.642**	$\chi^2(20) = 19.403$, p = 0.496**
Department store	t(210.742) = 3.500, p = 0.001	$\chi^2(20) = 24.597$, p = 0.217**	$\chi^2(20) = 25.643$, p = 0.178**

* Options "Never" and "Less than half of the time" and options "More than half of the time" and "I never bring my own bag" are combined.

** Nothing was combined, since this led to the same conclusion.

Statistical tests performed on Q18 If you forget to bring your own bag, which option would you choose?

	Gender	Age categories	Level of education
Supermarket	t(426) = -1.482, p = 0.139	$\chi^2(10) = 32.494$, p = 0.000*	$\chi^2(10) = 17.961$, p = 0.056*
Food-retail	t(390) = -1.490, p = 0.137	$\chi^2(15) = 22.217$, p = 0.102*	$\chi^2(24) = 30.113$, p = 0.181 Three lowest levels of education are combined
Clothing store	t(412) = -1.898, p = 0.058	$\chi^2(15) = 16.395$, p = 0.356*	$\chi^2(15) = 20.671$, p = 0.148*
Department store	t(405) = -2.142, p = 0.033	$\chi^2(15) = 20.374$, p = 0.158*	$\chi^2(15) = 16.083$, p = 0.377*

*The options "Thin plastic" and "Thicker plastic" are combined. Also the options "Fabric shopper", "Plastic shopper", "Foldable bag", "Jute" and "Cotton" are combined.

Statistical tests performed on Q34: Do you think that a ban on plastic bags in the city of Utrecht is a good idea?

Gender	Age categories	Level of education
t(430) = 3.192, p = 0.002	$\chi^2(10) = 9.741$, p = 0.464*	$\chi^2(10) = 20.833$, p = 0.022*

* Options "Very good" and "Good" are combined. Also options "Bad" and "very bad" are combined.

Statistical tests performed on Q35: Which one of the three scenarios do you prefer?

Gender	Age categories	Level of education
t(428) = -3.353, p = 0.001	$\chi^2(15) = 13.616$, p = 0.555	$\chi^2(15) = 16.874$, p = 0.326

Appendix H: Extensive table survey respondents

		Male	Female	Neither	Total
15 - 25	Primary school	1	0	0	1
	VMBO degree	0	5	0	5
	MBO degree	2	6	0	8
	HAVO/VWO degree	6	18	0	24
	Bachelor's degree	17	37	0	54
	Master's degree or higher	4	30	0	34
26 - 35	Primary school	0	0	0	0
	VMBO degree	0	0	0	0
	MBO degree	0	1	0	1
	HAVO/VWO degree	0	1	0	1
	Bachelor's degree	17	23	1	41
	Master's degree or higher	32	49	0	81
36 - 45	Primary school	0	0	0	0
	VMBO degree	1	0	0	1
	MBO degree	0	3	0	3
	HAVO/VWO degree	1	1	0	2
	Bachelor's degree	3	12	0	15
	Master's degree or higher	10	16	0	26
46 - 55	Primary school	0	0	0	0
	VMBO degree	0	1	0	1
	MBO degree	2	2	0	4
	HAVO/VWO degree	1	6	0	7
	Bachelor's degree	3	12	0	15
	Master's degree or higher	7	19	0	26
56 - 65	Primary school	0	0	0	0
	VMBO degree	1	0	0	1
	MBO degree	2	7	0	9
	HAVO/VWO degree	2	11	0	13
	Bachelor's degree	4	13	0	17
	Master's degree or higher	7	5	0	12
65+	Primary school	1	1	0	2
	VMBO degree	0	0	0	0
	MBO degree	0	6	0	6
	HAVO/VWO degree	0	8	0	8
	Bachelor's degree	1	6	0	7
	Master's degree or higher	5	7	0	12
Total		130	306	1	437

Appendix I: Survey respondent adjustments.

- It was assumed that with the implementation, the shopping behaviour of the consumers did not change. E.g. They went the same amount of times to the store and used the same amount of bags required for their purchased goods.
- When a question was left blank, it was assumed that another option was chosen than a carrier bag.
- When respondents answered for the question 11, 12 or 14 answers such as “between 2 and 10 times” the average of this answer was taken.
- One respondent answered for the supermarket in question 12, 100 times a month. This was considered as a typing error and was therefore deleted (other answers of this respondent did not show any peculiarity).
- One respondent, answered for the food-retail in question 12, 46 times a month. This was considered as a typing error and was therefore deleted.
- One respondent answered for the supermarket that 211 bags were required for each shopping trip. This was considered as a typing error and was therefore deleted.
- If in the results of the survey percentages of answers were shown, this was only calculated from the answers that were filled in. If questions were left unanswered these were not considered.
- When the calculation of monthly purchase of carrier bags led to unrealistic high values (above 50 bags per store type each month), these values were deleted. (For example, one responded said to go to a supermarket 25 times a month and use 25 bags for each trip and one responded said to use 8 bags per trip to a clothing store and went 15 times a month.) In total the response of 9 respondents were deleted for the calculation.
- Only males and females are being compared in the statistical tests. In the survey also “neither” was given as an option. Since only 1 respondent filled this in, this group is too small to perform statistical tests on. Therefore, this survey result is not considered when statistical tests are performed on gender. The result is considered in all the other tests and in the survey results. Next to this, 1 respondent did not fill in its age, therefore in the statistical tests on the age category this result was not considered. The result is considered in all the other tests and the survey results.

Appendix J: Most common series Q13, Q20, Q25 and Q30

Most common series of answers to the question *When you go to the following stores, which types of bag do you usually use or buy* per store type (questions 13, 20, 25 and 30). The tables show the number of respondents that gave that series of answers and the number of different combination given by all respondents.

Supermarket	Current situation	Scenario 1	Scenario 2	Scenario 3	Number of respondents
1	Own bag	Own bag	Own bag	Own bag	337
2	Other option	Own bag	Own bag	Own bag	23
3	Own bag	Other option	Own bag	Own bag	3
4	Thicker plastic	Own bag	Own bag	Own bag	6
5	Own bag	Own bag	Own bag	Cheapest option	5
5	Other option	Other option	Other option	Other option	5
Number of different combinations 39					

Food-retail	Current situation	Scenario 1	Scenario 2	Scenario 3	Number of respondents
1	Own bag	Own bag	Own bag	Own bag	249
2	Other option	Own bag	Own bag	Own bag	21
3	Paper bag	Own bag	Own bag	Own bag	14
4	Thin plastic	Paper bag	Own bag	Own bag	10
4	Thin plastic	Own bag	Own bag	Own bag	10
Number of different combinations 70					

Clothing store	Current situation	Scenario 1	Scenario 2	Scenario 3	Number of respondents
1	Own bag	Own bag	Own bag	Own bag	174
2	Paper bag	Paper bag	Own bag	Own bag	39
3	Paper bag	Own bag	Own bag	Own bag	38
4	Other option	Own bag	Own bag	Own bag	32
5	Paper bag	Paper bag	Cheapest option	Cheapest option	12
Number of different combinations 71					

Department store	Current situation	Scenario 1	Scenario 2	Scenario 3	Number of respondents
1	Own bag	Own bag	Own bag	Own bag	252
2	Other option	Own bag	Own bag	Own bag	24
3	Own bag	Paper bag	Own bag	Own bag	10
3	Paper bag	Paper bag	Own bag	Own bag	10
4	Paper bag	Own bag	Own bag	Own bag	5
Number of different combinations 76					

Appendix K: Consistency Q17, Q22, Q27

Most common series of answers to the question *How often do you forget to bring your own bag to a store?* per store type (questions 17, 22 and 27). The tables show the number of respondents that gave that series of answers and the number of different combinations given by all respondents. Next to this also the number of respondents of which the behaviour improved is shown and the amount of inconsistent series (series in which behaviour was worse after implementation of a ban on plastic bags).

Supermarket	Current situation	Scenario 1	Scenario 2	Number of respondents
1	Never	Never	Never	220 (50.3%)
2	Less than half of the time	Less than half of the time	Less than half of the time	104 (23.8%)
3	Less than half of the time	Never	Never	22 (5.0%)
4	Never	Less than half of the time	Less than half of the time	9 (2.1%)
5	Never	Less than half of the time	Never	7 (1.6%)
5	Half of the time	Less than half of the time	Less than half of the time	7 (1.6%)
Behaviour improved	69			
Number of different combinations	35			
Inconsistent answers	35			

Food-retail	Current situation	Scenario 1	Scenario 2	Number of respondents
1	Never	Never	Never	166
2	Less than half of the time	Less than half of the time	Less than half of the time	78
3	Less than half of the time	Never	Never	29
4	Less than half of the time	Less than half of the time	Never	21
5	Never	Less than half of the time	Less than half of the time	18
Behaviour improved	89			
Number of different combinations	56			
Inconsistent answers	95			

Clothing store	Current situation	Scenario 1	Scenario 2	Number of respondents
1	Never	Never	Never	106
2	Less than half of the time	Less than half of the time	Less than half of the time	90
3	Less than half of the time	Never	Never	33
4	Half of the time	Less than half of the time	Less than half of the time	25
5	Less than half of the time	Less than half of the time	Never	24
Behaviour improved	160			
Number of different combinations	67			
Inconsistent answers	63			

Department store	Current situation	Scenario 1	Scenario 2	Number of respondents
1	Never	Never	Never	135
2	Less than half of the time	Less than half of the time	Less than half of the time	105
3	Less than half of the time	Less than half of the time	Never	30
4	Less than half of the time	Never	Never	29
5	Half of the time	Less than half of the time	Less than half of the time	18
Behaviour improved	120			
Number of different combinations	52			
Inconsistent answers	66			

Appendix L: Difference in survey response by adjustments

Monthly bags purchased per person by survey respondents without adjustments

	Current situation	Scenario 1	Scenario 2	Scenario 3
Thin Plastic HDPE	2.15			
Thicker plastic LDPE	3.25			
Paper bags	1.57	2.62	1.52	
PP non-woven	0.08	2.03	3.44	3.88
PP Woven	0.17	0.99	0.40	0.39
PET bag	0.02	0.22	0.27	0.22
Jute bags	0.03	0.28	0.11	0.14
Cotton Bags	0.003	0.02	0.03	0.43
Total amount of bags	7.27	6.16	5.77	5.05
Average amount of plastic bags per person per month	5.40			
per year	64.96			

Monthly bags purchased per person by survey respondents with adjustments. These results differ from the results shown in SectionNumber of bags purchased in the city of Utrecht 4.3 because there the results were expanded with the different social-demographic characteristics, while these values are averages from the survey respondents.

	Current situation	Scenario 1	Scenario 2	Scenario 3
Thin Plastic	0.96			
Thicker plastic	1.87			
Paper bags	0.76	1.02	0.86	
PP non-woven	0.09	1.27	1.53	1.83
PP woven	0.17	0.55	0.45	0.44
PET bag	0.02	0.23	0.28	0.24
Jute bags	0.03	0.28	0.11	0.14
Cotton Bags	0.003	0.03	0.05	0.07
Total amount of bags	3.90	3.38	3.27	2.71
Average amount of plastic bags per person per year	2.83			
	33.98			

The monthly purchase of cotton bags increases between scenario 2 and 3 for the survey respondents. While, the results of the total number of cotton bags in Utrecht decreases between scenario 2 and 3. This is because of the way the survey results are expanded to the size of the city of Utrecht. In scenario 2 most of the cotton bags are purchased by males between the age of 25 and 36. While in scenario 3, most of the cotton bags are purchased by females between the age of 15 and 25. Because the group of male respondents in the age group of 25 and 36 is smaller, the expansion factor of this group is bigger. Therefore, this led to a higher number of purchased bags in scenario 2 for the whole of Utrecht.

Appendix M: Distribution of carrier bags among different stores

Current situation	Supermarket	Food-retail	Clothing store	Department store
HDPE bag	52%	33%	6%	9%
LDPE bag	83%	6%	4%	7%
Paper bags	0%	26%	51%	23%
Non-woven PP	70%	1%	13%	16%
Woven PP	96%	0%	0%	4%
PET bag	58%	0%	2%	41%
Textile bag; Jute	64%	36%	0%	0%
Textile bag; Cotton	0%	33%	0%	67%
Total of bags	58%	17%	14%	11%

Scenario 1	Supermarket	Food-retail	Clothing store	Department store
Paper bags	0%	47%	27%	26%
Non-woven PP	91%	2%	2%	5%
Woven PP	89%	8%	1%	3%
PET bag	78%	6%	7%	9%
Textile bag; Jute	91%	3%	0%	6%
Textile bag; Cotton	67%	14%	11%	8%
Total of bags	62%	17%	10%	11%

Scenario 2	Supermarket	Food-retail	Clothing store	Department store
Paper bags	0%	45%	25%	31%
Non-woven PP	88%	4%	2%	5%
Woven PP	87%	9%	2%	2%
PET bag	76%	13%	2%	8%
Textile bag; Jute	94%	1%	5%	1%
Textile bag; Cotton	87%	3%	1%	9%
Total of bags	62%	17%	9%	12%

Scenario 3	Supermarket	Food-retail	Clothing store	Department store
Non-woven PP	54%	20%	12%	15%
Woven PP	84%	11%	2%	4%
PET bag	65%	14%	13%	8%
Textile bag; Jute	91%	7%	1%	2%
Textile bag; Cotton	61%	14%	15%	10%
Total of bags	63%	17%	9%	11%

Appendix N: Distribution of the different bags within the store types

These results differ from the survey results since here the expansion to the city of Utrecht is implemented.

Current situation	Supermarket	Food-retail	Clothing store	Department store	Total
HDPE bag	22.9%	50.8%	11.6%	21.1%	25.8%
LDPE bag	67.3%	17.2%	12.7%	30.6%	47.2%
Paper bags	0.0%	30.5%	73.3%	41.0%	19.9%
Non-woven PP	2.8%	0.2%	2.2%	3.3%	2.3%
Woven PP	5.7%	0.0%	0.0%	1.2%	3.5%
PET bag	0.6%	0.0%	0.1%	2.4%	0.6%
Textile bag; Jute	0.6%	1.2%	0.0%	0.0%	0.6%
Textile bag; Cotton	0.0%	0.1%	0.0%	0.4%	0.1%
	100%	100%	100%	100%	100%

Scenario 1	Supermarket	Food-retail	Clothing store	Department store	Total
Paper bags	0.0%	82.5%	85.6%	69.9%	30.4%
Non-woven PP	53.7%	5.3%	6.1%	15.3%	36.4%
Woven PP	22.3%	6.9%	1.5%	3.5%	15.5%
PET bag	7.9%	2.1%	4.6%	5.0%	6.3%
Textile bag; Jute	14.1%	1.8%	0.0%	5.0%	9.6%
Textile bag; Cotton	2.0%	1.5%	2.2%	1.2%	1.8%
	100%	100%	100%	100%	100%

Scenario 2	Supermarket	Food-retail	Clothing store	Department store	Total
Paper bags	0.0%	75.6%	81.8%	73.0%	28.7%
Non-woven PP	64.6%	11.7%	11.6%	19.5%	45.6%
Woven PP	20.3%	7.9%	3.1%	1.9%	14.4%
PET bag	6.9%	4.3%	1.5%	3.9%	5.6%
Textile bag; Jute	5.3%	0.1%	1.8%	0.2%	3.5%
Textile bag; Cotton	3.0%	0.4%	0.3%	1.5%	2.2%
	100%	100%	100%	100%	100%

Scenario 3	Supermarket	Food-retail	Clothing store	Department store	Total
Non-woven PP	56.6%	77.6%	81.0%	86.1%	65.7%
Woven PP	24.9%	11.7%	4.8%	5.9%	18.7%
PET bag	8.2%	6.8%	10.7%	5.6%	7.9%
Textile bag; Jute	8.5%	2.3%	0.5%	0.8%	5.8%
Textile bag; Cotton	1.9%	1.6%	3.0%	1.7%	1.9%
	100%	100%	100%	100%	100%

Appendix O: Shadow cost per impact category for the different scenarios

The numbers between brackets is the percentage of the Impact category in the total shadow price.

Impact category	Climate change	Ozone depletion	Terrestrial acidification	Freshwater eutrophication	Marine eutrophication	Human toxicity	Terrestrial ecotoxicity	Agricultural land occupation	Urban land occupation	Water depletion	Total
Shadow costs (€)											
Current situation	2.96E+03 (30%)	2.09E-01 (0%)	4.01E+02 (4%)	2.03E+01 (0%)	3.50E+02 (4%)	3.68E+02 (4%)	2.19E+01 (0%)	4.57E+03 (47%)	8.45E+01 (1%)	9.41E+02 (10%)	9.72E+03
Scenario 1	9.77E+03 (29%)	5.52E+00 (0%)	1.44E+03 (4%)	9.78E+01 (0%)	2.01E+03 (6%)	1.17E+03 (4%)	3.59E+02 (1%)	9.31E+03 (28%)	2.22E+02 (1%)	8.98E+03 (27%)	3.34E+04
Scenario 2	8.60E+03 (34%)	5.78E+00 (0%)	1.14E+03 (5%)	5.75E+01 (0%)	1.35E+03 (5%)	8.68E+02 (3%)	3.71E+02 (1%)	7.05E+03 (28%)	1.60E+02 (1%)	5.37E+03 (22%)	2.50E+04
Scenario 3	9.67E+03 (47%)	4.27E+00 (0%)	1.25E+03 (6%)	5.25E+01 (0%)	1.39E+03 (7%)	8.53E+02 (4%)	2.77E+02 (1%)	2.08E+03 (10%)	1.18E+02 (1%)	4.93E+03 (24%)	2.06E+04

Appendix P: Results littering potential

The values shown in the table were used to determine the ranking in Section 4.4.2

Combination	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
HDPE	1429	1429	64789	64789	66694	1715	1715	77747	77747	80033	1429	1429	64789	64789	66694
LDPE	181	181	8184	8184	8425	227	227	10312	10312	10615	190	190	8593	8593	8846
Paper	33.43	50.15	33.43	33.43	34.41	42.12	63.18	42.12	42.12	43.36	35.10	52.65	35.10	35.10	36.13
PP non-woven	9.93	9.93	450.04	450.04	463.28	9.93	9.93	450.04	450.04	463.28	9.93	9.93	450.04	450.04	463.28
PP woven	7.66	7.66	347.26	347.26	357.47	7.66	7.66	347.26	347.26	357.47	7.66	7.66	347.26	347.26	357.47
PET	17.96	17.96	814.39	814.39	838.34	22.64	22.64	1026.13	1026.13	1056.31	18.86	18.86	855.10	855.10	880.25
Jute	1.45	0.97	0.97	13.18	0.71	1.83	1.22	1.22	16.60	0.90	1.53	1.02	1.02	13.84	0.75
Cotton	1.92	1.28	1.28	17.44	0.94	2.42	1.62	1.62	21.97	1.19	2.02	1.35	1.35	18.31	0.99

Appendix Q: Interview Public service of Wallonia

Informed consent form

Research title: Environmental impact of banning plastic carrier bags in the city of Utrecht.

Responsible researcher: Selma de Leeuw

To be completed by the participant

I agree that I'm informed about the nature, method and purpose of this research. I understand that the content of this interview will be treated anonymously and confidential. My questions about this interview and the research have been answered to my content. I understand that all the answers from this interview will be used for analysis purpose only. I voluntarily agree to take part of this interview. I understand that I can withdraw from the study at any time, without any penalty or consequences. I grant permission for the data generated from this survey to be used in the researcher's publication on this topic.

I acknowledge that I have read, understood and agree with the above.

Name participant: Taminiaux Anne-Florence

Date: 10/02/2020

Place: Namur, Belgium

To be completed by the researcher

I have given an explanation the research. I will answer remaining questions. The participant will not experience any consequences from withdrawing from the study at any time.

Name researcher: Selma de Leeuw

Date: 06-01-2020

Place: Utrecht

Name: Taminiaux Anne-Florence

Function: Attachée qualifiée (I don't know the correspondence in English)

Country: Belgium

City or municipality: Walloon Region

Date:

1. Could you give a short explanation how you were involved in the implementation of legislations concerning plastic carrier bags?

I'm in charge of the monitoring of this legislation. I'm also the contact point to explain the legislation to citizens, society, merchants,...

2. What was the exact implemented legislation concerning carrier bags? (Tax, levy or ban? Could you specify this per type (plastic and/or paper) of bag? Was there distinction made between different thicknesses of bags?)

The ban on the use of single-use plastic bags, whether free or paid, is gradually being introduced in Wallonia.

The legislation introduces the ban of the use of light plastic bags and very light for single use when shopping in retail shops, whatever their composition (materials of vegetable or non-vegetable origin, recycled or non-recycled materials) and their characteristics (recyclable or not, compostable or not).

This ban is applies since **1st December 2016** for cashier bags.

For plastic bags other than cashier bags, the ban is or will be applies :

- From **1st March 2017**: for the packing of non food
- From **1st September 2018**: for packaging of foodstuffs other than bulk fruits and vegetables;
- From **1st March 2020**: for primary packaging of fruit and vegetables sold in bulk.

Exceptions :

- For the primary packaging of aquatic plants and aquatic animals;
- For packaging by the retailer of wet, liquid or liquid foodstuffs sold at retail. The bags concerned have, from **1st January 2018**, a minimum content of 40% biosourced material and 60% from **1st January 2025** and they are compostable at home. These bags must be sealed at the service counter;
- For the packaging of liquids, aerosols and gels purchased at a point of sale of an airport beyond the check-point for boarding.

3. When was this regulation implemented?
See point 2

4. What was the incentive for implementing this legislation? (For example, was there pressure from a political party, public pressure, action group, implementation of a new law etc.)

Several objectives are pursued for the benefit of the environment:

- reduce the consumption of single-use plastic packaging (waste prevention, resource saving), in favour of more sustainable packaging;
- encourage the recovery of plastic bags still allowed (home composting or recycling as appropriate),
- limit the presence and impact of plastic packaging in the environment (abandoned waste, bags that have blown away, end up in the oceans, etc.).

5. How long did it take for the legislation to be implemented? (From idea to actual implementation. Was there a test phase?)

2 years

6. How was information about the upcoming legislation spread? / How was awareness created under inhabitants of the city? (For example, with information meetings/nights or campaigning?)

A communication campaign is launched since 2017 to inform various publics about the ban on single-use plastic bags in Wallonia, and to encourage consumers to adopt other packaging habits :

- Creation of a page devoted tot this thema on the website

<http://moinsdedechets.wallonie.be>

- Realisation of a communication kit available to citizens, merchants,...: Folder explanatory, poster (in French and German) and flyers : <http://moinsdedechets.wallonie.be/fr/je-m-engage/interdiction-des-sacs-en-plastique-usage-unique>

- The production of advertising inserts for French-language Belgian press titles

- The preparation, production and distribution of a comic book script per month : [site moinsdedechets.wallonie.be](http://moinsdedechets.wallonie.be) and [page Facebook Environnement Wallonie](#)

7. Has there been an evaluation of results from the implemented legislation? (e.g. by looking into the share of plastic bags in the waste stream, or by asking the population about their bag use, etc)

Yes, we entered into a public contract with a private consultancy office to evaluate the implementation of the ban.

8. If yes, what were the results of this evaluation and what was learned from these results?

I can't give you the results because they are not yet public.

9. How was the new legislation accepted? (By different political parties or inhabitants?)

In the context of the pollution caused by plastic waste, the legislation was well accepted by the citizens. The merchants accept it if they are well informed.

10. Was there resistance in the implementation of the legislation, and from who?

There was a lot of resistance from the distribution and petrochemical sectors during the development of the legislation. Both defended the use of plastic.

Finally, the legislation is the product of discussion and compromises with the sector.

11. Can you name the barriers and facilitators that you were facing during the implementation of the legislation?

The definition of reusable bag is not easy. Indeed, for a bag to be reusable according to the Walloon legislation, it must have a thickness of 60 microns and be used for the same purpose at least 20 times.

In addition, a bag can be resistant but have a format that does not guarantee its reuse. It is therefore necessary to avoid mini-formats or special forms which restrict the possibilities of reuse.

12. Can you name some pitfalls that should be avoided when a city wants to implement a ban on (plastic) carrier bags?

The legislation must be as easy as possible. The legislation must cover criteria that can easily be measured.

13. If the City of Utrecht wants to implement a ban on all plastic carrier bags, can you give some advice for the municipality?

See point 12

14. Any other comments regarding this topic?

No