Lehrstuhl für Abfallverwertungstechnik und Abfallwirtschaft

Masterarbeit

Determination of major drivers influencing the behaviour of private waste producers in Barcelona/Spain and Leoben using Multi Criteria Decision Analysis

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Kurzfassung

Ermittlung der Haupteinflussfaktoren auf das Verhalten privater Abfallerzeuger in Barcelona/Spanien und Leoben mittels multikriterieller Entscheidungsanalyse

Ziel dieser Arbeit ist es, einen Beitrag zur Optimierung des Abfalltrennverhaltens zu leisten. Um dieses Ziel zu erreichen, wurden Haupteinflussfaktoren auf besagtes verhalten identifiziert. Im ersten Schritt wurde eine umfassende Literaturrecherche durchgeführt, um zu ermitteln, welche Faktoren bereits in früheren Studien diskutiert wurden. Diese Faktoren wurden dann in zwei Gruppen eingeteilt: nicht-demographische Faktoren und demographische Faktoren. In dieser Form wurden die Faktoren einer Gruppe von Experten in den Bereichen Abfallmanagement, Nachhaltigkeit und Soziologie und Verhaltensforschung präsentiert, sowie einer Bevölkerungsgruppe aus Barcelona und einer aus Leoben. Diese Gruppen wurden gebeten, diese Faktoren basierend auf ihrer Wichtigkeit zu ranken. Die erhaltenen Rankings wurden dann für jede gruppe Einzeln mithilfe von „Pairwise Comparison Matrices“ verarbeitet, um Gewichtungen für die einzelnen Faktoren zu erhalten. Die Ergebnisse der Gruppen wurden diskutiert, miteinander verglichen und versucht die Unterschiede zu interpretieren. Sie zeigen, dass es sich bei den wichtigsten nicht-demographischen Faktoren um intrinsische Faktoren wie „Überzeugungen und Werte“, „Gewohnheiten“ und „Sorge um die Umwelt“ handelt. Der einzige wirklich wichtige externe Faktor ist „Bequemlichkeit des Sammelsystems“. Die Ergebnisse zeigten des Weiteren, dass die befragten Gruppen eine sehr ähnliche Wahrnehmung dieser Faktoren haben. Einer der wichtigsten demographischen Faktoren ist „Ausbildungsniveau“. Von den Gruppen wird ein Zusammenhang dieses Faktors mit Wissen und Verständnis für Umweltprobleme und den Recyclingprozess wahrgenommen. Ebenfalls sehr wichtig ist der Faktor „Standort“, welcher eine Verbindung zu der Art des Sammelsystems und damit auch zur Bequemlichkeit, welche eine Person bei der Mülltrennung erfährt, aufweist. Die Ergebnisse zeigen auch, dass die Wahrnehmungen der Gruppen bezüglich der demographischen Faktoren höhere Unterschiede aufweisen, als bezüglich der nicht-demographischen Faktoren. Der Vergleich der wahrgenommenen Wichtigkeit der nicht-demographischen Faktoren mit jener der demographischen Faktoren zeigt, dass alle Gruppen der Ansicht sind, dass die demographischen Faktoren den größeren Einfluss haben.

Abstract

Determination of major drivers influencing the behaviour of private waste producers in Barcelona/Spain and Leoben using Multi Criteria Decision Analysis

The objective of this thesis is to engage in the optimization of waste separation behaviour. To reach this objective, major drivers which influence said behaviour were identified. In the first step a literature research was executed to find drivers which were already discussed in former studies. These drivers were divided into two groups: the non-demographic drivers and the demographic drivers. In this form they were then presented to a group consisting of experts in waste management, sustainability and sociology and behaviour studies, as well as to a population of Barcelona and one of Leoben. These groups were asked to rank these drivers according to their importance. The obtained rankings were then processed for each group separately via pairwise comparison matrices to obtain weightages. The results of the different groups were discussed, compared and the differences interpreted. They show that the most important non-demographic drivers are internal drivers like “Beliefs and values”, “Habits” and “Environmental concern”. The only really important external driver is “Convenience of the collection system”. It was also found that the perceptions of the three questioned groups about the non-demographic drivers are very similar. One of the most important demographic drivers is “Level of education” which seems to be perceived to be related to knowledge and understanding about environmental issues and the recycling process. Also very important is the driver “Location” which is connected to the type if collection system and therefore, also to the convenience a person experiences during waste separation. It was found that the results for the demographic drivers show greater diversity between the groups than the results for the non-demographic drivers. The comparison of the importance of non-demographic and demographic drivers show, that all groups perceive the non-demographic drivers to have a bigger influence.

Content

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Glossary

Here words, phrases and variables that are used in the following study are explained shortly.

Table 1: Used variables in the further study

Variable	Explanation
A	pairwise comparison matrix
a_{ij}	$entry_{ij}$ = result of the pairwise comparison of factor i with factor j
c	consistency vector; obtained by dividing weight vector w_s by priority vector w.
CI(A)	Consistency index of pairwise comparison matrix A
CR(A)	Consistency ration of the pairwise comparison matrix A
m_i	mean rank of a driver obtained out of the population survey
n	eigenvalue of a pairwise comparison matrix
n	amount of compared criteria
RI_n	Random index of a random pairwise comparison matrix with the amount of elements n
v_i	mean variance of the assigned ranks assigned in the population survey from the mean rank of the driver
w	priority vector/ eigenvector of a pairwise comparison matrix
w_s	weight vector; obtained by multiplying pairwise comparison matrix A with priority vector w
x_{iz}	amount of times a rank was assigned to the driver
z	rank which can be assigned to a driver (values from 1-12)
λ_{max}	maximum eigenvalue of a pairwise comparison matrix
ω_i	value of the criterion i
ω_j	value of the criterion j

Table 2: Glossary of some important words and phrases

Word	Meaning
Abitur	Grade with which high school completed. Necessary to be able to study at a university
altruistic	refers to actions which are done to improve the situation of other people or the surrounding environment
Analytich Hierarchy Process	a type of deciscion making process which uses pairwise comparison
demogarphic	relates to the demography of a population
driver	internal or external factor that inlfuences waste separation behaviour
elderly people	people above the age of 65
immigrants	people that moved to a country and have their center of live there. The reason for moving is not important
informal norms and ethics	norms and rules that are not written down but common behvaiour in a society
kerbside recycling scheme	a collection system where waste gets picked up directly infront of the residence
middle-aged adults	people between the age of 30 and 65
Multi Criteria Decisicon Analysis	a decision making process when various criteria is given
non-demographic	does not relate to the demography of a population
norm	internal believe about what is right or wrong
normative beliefs	individuals' beliefs about the extent to which other people who are important to them think they should or should not behave in a certain way
responsibility ascription	the act of referring a responsibility to a person/group/organisation
salient	most important
senior residents	people with an age above 65
subjective norm	a persons perception of whether other individuals or society think one should perform a certain behavioiur
technical-organisational	refers to technical or organisational aspects of a system
upper milieu	people within the age between 40 and 70 with middle to high income
young families	parents of the age between 20 and 40 with babies or younger children
younger people	people between the age of 14 and 30

Table 3: Glossary of used abbreviations

Abreviation	Meaning
ACORN	British consumer classification system
AHP	Analytic Hierarchy Process
CDU	Christlich Demokratische Union Deutschlands (german political party)
D	Demographic driver
Dr.	Doctor
FDP	Freie Demokratische Partei (german political party)
GP	Goal programming
MADA	Multi-Attribute Decision Analysis
MCDA	Multi-Criteria Decision Analysis
MCDM	Multi Criteria Decision Making
MEng.	Master of Engineering
MUL	University of Leoben (Montanuniversität Leoben)
ND	Non-demographic driver
Prof.	Professor
SPD	Sozialdemokratische Partei Deutschlands (german political party)
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
TV	Television
UPC	Universitat Politècnica de Catalunya
WRAP	British waste and resources action program

1 Introduction

1.1 Objective of the thesis

The importance of separate collection of reusables is contineously growing due to the need for conservation of ressources and the avoidance of green house gases from landfills. Furthermore, the separate collection of different waste fractions ensures that incineration plants and landfills can be managed properly. (Friege, 2021, p. 11) The objective of this study is to engage in the optimization of source segragation by identifying major drivers which influence waste separation behaviour.

The research question which was answered in this study was:

“What are the major drivers that influence waste separation behaviour and which differences in perception exist between habitants of Barcelona, habitants of Leoben and a diverse expert group?”

1.2 Scope of the project

This thesis was executed in the City of Barcelona with participation of the Universitat Politècnica de Catalunya (UPC) and the University of Leoben (MUL). Supervisors were Prof. Dr. Daniel Vollprecht and Ms. Namrata Mhaddolkar, MEng. for the MUL and Prof. Dr. Lázaro V. Cremades Oliver for the UPC. The thesis and it’s results are meant to contribute to the research of Ms. Namrata Mhaddolkar, MEng. which is executed for her dissertation about “Development and evaluation of waste collection and sorting systems for bioplastics”.

To identify drivers for waste separation behaviour which were found in previous researches an extensive literature research has been executed. These drivers were then presented to experts in the areas of waste management, sustainability and behavioral science around Europe from different sectors (academia, governmental organizations and so on), to rank them based on their expertise & experience. Also, the importance of these drivers for the private waste producers was assesed via a survey in Barcelona and Leoben. The results of these groups were then analyzed with the help of the Analytic Hierarchy Process and compared to each other afterwards. The working process and the results of the study are presented on the following pages.

2 Theoretical part

In this part the literature research on drivers which have been discussed by formers studies as well as the literature research on Multi Criteria Decision Analysis (MCDA) and Analytic Hierarchy Process (AHP) is presented.

2.1 Literature research on the drivers

To identify relevant factors which influence waste separation behaviour, an extensive literature research was executed. The found drivers were then presented to experts of the waste sector, which were asked to rank them according to their experience.

2.1.1 Process of the research

The literature research was mainly executed via the online library of the University of Leoben, Google and Google Scholar. In English as well as in German, studies which engage in the relation of psychological factors, sociodemographic drivers as well as non-sociodemographic drivers to waste separation behaviour, have been searched. To find relevant studies, keywords like “waste separation”, “factors for waste separation”, “influences on waste sorting”, “waste sorting behaviour”, “Einflüsse auf das Abfalltrennverhalten” and “Einflüsse Abfalltrennung”, etc. were used. In the further process, 8 relevant studies were identified and summarized. Additionally, the relevant reference literature (35 additional papers) was looked into. Out of these summaries and the reference literatures, the main mentioned drivers were then identified by counting their appearances in these summaries. This way, 24 different drivers were extracted. These drivers are discussed in the next pages of this paper.

2.1.2 Results of the research – Found drivers

In the following section the found drivers are presented. They are divided into two groups: the non-demographic drivers and the demographic drivers.

2.1.2.1 Non-demographic drivers

The non-demographic drivers include technical-organisational drivers as well as psychological drivers. Both of these categories have a high impact on a persons’ attitude towards waste separation and also the actual behaviour.

2.1.2.1.1 Appearance and design of infrastructure

Out of the studies of Miafodzjeva et al. (2013) and Hage and Söderholm (2008) it can be taken that appearance and design of collection points is an important external factor (Becker, 2014, pp. 11–12).

In the study of Miafodzyeva et al. (2013, p. 226) it was also shown, that tidiness of the recycling sites, the design of collection points and easy access are influencing the convenience of recycling and therefore, have an effect on waste separation behaviour.

a) Tidiness and arrangement of containers

The associations with recycling strongly relate with the appearance of the recycling station. Therefore, high tidiness is needed to keep up the moral participation. A clean and tidy environment indicates the worth of the materials. Furthermore, the arrangement of the containers has an influence on sorting behaviour. Placing the container for mixed household waste as the easiest one to reach, the temptation is high to dispose all sorts of waste there. (Becker, 2014, p. 33)

b) User-friendly design for marginal groups

For younger, elderly and disabled people it could be difficult to use the currently provided infrastructure as the containers are designed for average grown up individuals. Lifting the lid, carrying waste and reach up to the higher located openings however could be difficult for people who cannot be ascribed to this group. Especially heavy glass, metal waste and biological waste can be a problem for less physically fit residents or for people with reduced mobility, if the collection points and containers are not designed in an appropriate way. Furthermore, children cannot participate in separate waste collection if they cannot reach or lift the lid of containers (Becker, 2014, p. 16). Interaction with waste should be designed in a child-friendly way. Children can be easily integrated in recycling activities if collection points in their daily life are easily accessible. Also tidiness is an important aspect when children want to be motivated towards recycling, as for example broken glass can represent a threat to them. (Becker, 2014, p. 35)

2.1.2.1.2 Awareness campaigns

Awareness campaigns are meant to motivate people to act in a certain way and transport knowledge about a certain topic. However, it is important to know how to address the different groups in a society, as not every group can be motivated in the same way. In the following points a few examples are shown on how to address certain groups of society.

a) Elderly people

As a lot of elderly people who still live alone are supported by care services, the employees of these services are an important target group for recycling information (Becker, 2014, p. 35).

b) Students

As the focus of students mostly lies on other issues (time, money, social activities, school) it could be more important to provide information on how to recycle than why to recycle. To keep the participants motivated frequent educational meetings about recycling could be an option. Addressing an influential person of the social group directly, has also been found as effective for promoting recycling. This group could also be reached effectively via their interest groups and associations. (Becker, 2014, p. 33)

c) Immigrants

Immigrants that live in bigger, shared houses can be roughly compared to students living in student accommodations. They are also part of a social group with strong social connection. Therefore, for them frequent meetings about how to recycle could be helpful to keep the contribution high. Also, addressing a person, they can relate to, which can convey reasons and knowledge about how to recycle in their own language, is important. It was also found that underprivileged households watch TV more often. So this media could provide a good alternative to reach these households. (Becker, 2014, p. 33)

Immigrants could too be addressed via language courses. Also children can function as a channel for information by bringing home knowledge they learned in school. The influence of children may, however, be lower in paternalistic cultures. (Becker, 2014, p. 37)

d) Residents with higher environmental education

For the group of residents with higher environmental education, campaigns to increase participation in recycling behaviour should try to activate altruistic norms. However, it is also assumed that this group wants to acquire knowledge and engage in debates. Therefore, also information about how the collected waste is further processed and used could be appreciated. As this group (in Sweden) also consists of high educated immigrants, they could also be addressed in English. (Becker, 2014, p. 32)

2.1.2.1.3 Beliefs and values

Out of studies of Miafodzyeva et al. (2013) and Hage (2008) it can be taken that internal factors like personal moral norm and attitude are factors that affect recycling behaviour. (Becker, 2014, p. 11)

a) Attitude towards a behaviour

In the work of Ajzen & Fishbein (1975, p. 6) attitudes are defined as *"a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object"*.

Ajzen (1991, p. 188) later defined this construct as the favourable or unfavourable appraisal an individual holds regarding a particular behaviour. Salient behavioural beliefs of the individual influence this construct (Armitage and Conner, 2001, p. 474).

The work of Matthies (1994, pp. 36–37) gives an overview over various studies about attitudes affecting recycling behaviour. Although the studies had different procedural methods the findings are exceptionally homogeneous. Most of the studies show a significant correlation between attitude and waste behaviour. The attitudinal factors include norms, beliefs and values of an individual while external conditions consist of government regulations, monetary incentives, built environment, advertising and information. The conclusion of this study was that an individual performs pro-recycling behaviour if the individual has a positive attitude towards recycling, while external factors can reinforce this behaviour. However, the authors make the assumption that *"attitude theories [...] lose predictive value as external conditions increase in strength"*.

Rückert-John et al. (2021, p. 63) also make the assumption that the waste avoiding practices are not only motivated by the attitude but that also other requirements have to be fulfilled. And Stoeva and Alriksson (2017, p. 739) found that when people are satisfied with the local waste collection system, participation or quality of separation can be increased by creating more positive attitudes towards waste separation. This can be achieved by increasing separation related and environmental knowledge, and moral obligation (Dongliang et al., 2015, p. 9485).

b) Personal norm and felt responsibility

Personal norms refer to an individual's feeling of moral obligation to perform a certain behaviour (Schwartz, 1977, p. 227). Lingqiong et al. (2022, p. 10) found that personal norms significantly affected the waste behaviour of the participants of their study. This leads to the assumption that moral concern is an essential factor driving waste behaviour.

Out of this moral concern a felt responsibility towards a certain topic can develop. This feeling of responsibility is a strong driving force for individuals to participate in waste separation (Miafodzyeva et al., 2013, p. 228). Berglund (2006, p. 568) found, that if the felt responsibility of an individual to participate in recycling is higher, the costs (time, effort) of the action are perceived lower than if the individual does not feel this responsibility. It can be said that the group of recyclers feel a responsibility towards environmental problems and have the belief that their own actions can contribute to environmental protection. In other words, they mainly have intrinsic motivation (Brenncke, 2004, p. 9).

2.1.2.1.4 Convenience of the collection system

In a study of Boldero (1995, p. 448) it was found that besides "lack of conviction", "inconvenience" is the main reason for missing motivation for recycling. Especially for the group of non-recyclers convenience is very important (Brenncke, 2004, p. 9). The Low-Cost-Thesis also is based on the assumption that environmental attitude and environmental behaviour are most likely to be preferred when the costs of this behaviour are low. Hereby, with costs there are not only material costs implied but also immaterial costs such as time consumption, physical effort and the loss of comfort. Therefore, a person is most likely to transfer their environmental attitude in corresponding behaviour if the costs for transferring are low. When these costs are higher, the willingness for environmental friendly actions declines. (Brenncke, 2004, pp. 31–32) This can be confirmed by Ungar (1994, p. 296) who states in his article that *"few people want to give up anything, however, if there is opportunity at low cost, they will use products and engage in actions that are more efficient or benign"*.

a) Implications of convenience

Becker (2014, p. 7) mentions convenience in relation to organizational structure, which is by a high share provided by local waste management organizations. High convenience includes high frequency of collection, short distances and strategic positioning of collection points and their appearance as well as appropriate storage space in the household.

It could be confirmed in the studies of Miafodzyeva et al. (2013) and Hage and Söderholm (2008) that the availability and presence of containers and collection points also have an important effect. (Becker, 2014, pp. 11–12)

Distance also seems to be relevant for residents of flats without close collection points, as taking recyclables to a central collection point makes recycling more inconvenient (Becker, 2014, p. 15). To arrange comprehensive and convenient waste sorting facilities characteristics of residential layout, population size and other factors should be taken into account. Garbage facilities should be easily accessible, easily identifiable and reasonably located. (Shen et al., 2019, p. 11)

b) Dependence on collection scheme

Recycling behaviour too depends on the available collection scheme. This includes containers, vehicles, methods, distance and positioning of collection points, etc. The provided scheme is dependent on natural conditions (climate, soil, etc.) and man-made conditions (housing, population density, etc.). Dongliang et al. (2015, p. 9485) found that the share of people who think waste separation is inconvenient is higher in communities where residents have to bring their waste to collection points. In literature, it was found that there exists a conflict between the collector and the household. On the one hand, the

collector wants good accessibility and central collection points. (Miafodzyeva et al., 2013, p. 225)

On the other hand, it was also observed that kerbside collection clearly improves the separation of recyclables within a population (Dahlén et al., 2007, p. 1305).

c) Loss of influence if functioning systems are given

The variable "satisfaction with local facilities" is of no use if functioning waste collection systems are given and the people are satisfied with the conditions. The behaviour of Swedish students in Stoevas and Alrikssons (2017, p. 739) study was mainly determined by their intention to execute and influenced by their attitude towards waste separation. While satisfaction with the local facilities was not important for the behaviour of the Swedish participants, it acted as a barrier for participation for the Bulgarian group. The Swedish participants felt that they possessed more control over the situation compared to the Bulgarians. This means, providing satisfactory conditions in the living areas of people can potentially increase the rate of recyclers and of correctly separated materials.

d) Importance of margin groups

Younger, older and disabled residents may be discouraged by longer distances to collection points. Parents also might feel anxious about sending children to collection points where the distance is too far. (Becker, 2014, p. 16)

Elderly people who are still living on their own too might have problems with the distance to the next recycling station. Especially, residents with physical restraints are hindered in participation in recycling by carrying bags for long distances to a recycling station. (Becker, 2014, p. 35)

2.1.2.1.5 Economic incentives

In this study economic incentives not only include economic rewards like money or coupons, but also the avoidance of costs and penalties by participating in waste separation.

The study of Becker (2014, p. 7) has shown, that economic incentives have a small impact on actual recycling behaviour. Vining and Ebreo (1990, p. 65) found that economic incentives are more important to non-recyclers than they are to recyclers. This means, the group of non-recyclers could be influenced towards recycling by economic rewards (Brenncke, 2004, p. 9). Especially students could be motivated by economic incentives like free lunch or cinema tickets. But economic incentives could also animate other lower-income groups to participate in recycling. (Becker, 2014, p. 33)

This could also be found by Shen et al. (2019, p. 11) who think rewards for the classification of municipal solid waste could rise the willingness of young people in china to classify correctly.

2.1.2.1.6 Environmental concern

Environmentally friendly behaviour can be seen as an altruistic act with the purpose of improving well-being of living beings or conserving nature. This statement can be deduced out of the studies of Dunalp et al. (2000) and Stern (2000). According to these two studies, environmental concern too is a critical factor influencing environmental behaviour from the altruistic perspective. It contributes to developing personal norms through consequence awareness and responsibility ascription. (Lingqiong et al., 2022, p. 3)

It was shown that greater awareness for the environment and the resulting concern are important factors to participate in recycling (Becker, 2014, pp. 7–8). Bödege-Wolf (1994, p. 43) points out that in surveys environmental consciousness is linked by the participants to the willingness to separate municipal waste, to pay higher prices for sustainable products and to accept higher public spending. However, this willingness is not identical with the real behaviour of the participants. Although most people feel concerned by environmental pollution, this feeling does not affect the behaviour of many. This leads to the question what causes the discrepancy between environmental consciousness and environmental behaviour (Brenncke, 2004, p. 28).

Bödege-Wolf (1994, p. 43) sees the reason for that in social phenomenon and early childhood impressions. Often convenience and the desire for pleasure direct the behaviour, as well as formative early learned patterns. Also external circumstances such as lack of space can prevent an individual from executing real action (Barr et al., 2013, pp. 72-73). A research of Eckes and Six (1994, pp. 253-254) shows that this discrepancy was even increasing over the years and that the waste and recycling area was especially peculiar. It could be assumed that environmental consciousness has separated itself from waste sorting. One possible reason for that is that in people’s eyes waste sorting does not bring significant environmental improvement. Furthermore, many young people feel that they already have done their part by putting their garbage in the trashcan (Shen et al., 2019, pp. 12–13). The question raises how to motivate people to behave environmentally friendly if informal education about the environmental situation and the necessary actions are not enough anymore.(Brenncke, 2004, p. 29)

2.1.2.1.7 Environmental education

The studies of Miafodzyeva et al. (2013) and Hage and Söderholm (2008) show that information about recycling issues is an external factor that influences recycling behaviour (Becker, 2014, p. 11). Also Hines et al. (1987, p. 1) found that knowledge about environmental issues and action strategies are critical factors which influence pro-environmental behaviour. And Mathies (1994, pp. 40-41) compared various studies which evaluated the connection of knowledge and recycling behaviour. The majority of these studies show a relation between environmental knowledge and willingness to separate reusable materials. It can be assumed that knowledge about the processes and the positive environmental effect of recycling helps to build trust in the complex and non-transparent system of recycling. This in return leads to an understanding of the usefulness of the participation in recycling. (Brenncke, 2004, pp. 25–26)

This could be confirmed by a study of Kossakowski (1999, p. 91) where the group of non-separators had a considerable lack of knowledge. Statements of this group show that there is often either a false or no idea about the separation of waste. They also have doubts about the further recycling process and the applicability of the correctly separated materials.

However, Poferl et al. (1997, p. 58) wants to point out that in modern societies environmental knowledge is often communicated by media. It has to be taken into account that layman's knowledge comes from various sources which do not have to be scientific. Especially in media science should be entertaining and is wanted to attract a lot of consumers rather than to permit an objective insight on a situation.

To cultivate norms, values and public awareness, waste sorting should be content of basic education. This way civilization can be encouraged continuously to participate in municipal waste sorting and the recycling process. Therefore, it is suggested that lectures in classes, communities and companies should be implemented to develop garbage classification standards and skills. (Shen et al., 2019, p. 12)

It could be especially beneficial to educate young people and practice environmentally friendly waste behaviour with them, because often habits which are adapted in early childhood cannot be changed anymore as adult. In schools the possibilities would be given to have an educational effect on children and their waste consciousness. (Brenncke, 2004, p. 25)

Furthermore, children can influence their family towards recycling and their education may have greater impact than just raising waste conscious children. However, the messages to

address children should be easy to understand and not require much pre-knowledge. (Becker, 2014, p. 35)

2.1.2.1.8 Governmental regulations

Governmental regulations like laws and restrictions are meant to direct a populations behaviour in a certain way. They determine our lives in many aspects. But to be effective, these regulations also have to be controlled, and violating them has to have certain consequences. To influence waste separation behaviour could therefore be a difficult task to do.

However, the majority of the participants of the study of Rückert-John et al. (2021, p. 63) sees politics and companies as responsible to do something against the waste problem. 86% of the asked persons think that politics should do more and 91% think that producers and the commerce sector are responsible to reduce packaging waste. Also, Shen et al. (2019, p. 13) came to the conclusion that a way to improve participation in waste separation in China is the improvement of laws and regulations on waste sorting and their implementation.

2.1.2.1.9 Habits

Habits represent a routine behaviour that is mostly learned and developed while growing up. Therefore, habits are hard to be influenced or even changed.

A study of Brenncke (2004, p. 30) found that habits have an impact on a person's behaviour and can often prevent an individual from transferring an environmentally friendly attitude into real pro-environmental actions. Rückert-John et al. (2021, p. 63) too found that daily habits can affect waste avoiding practices. It could be noticed, that the earlier recycling habits were acquired from the family environment, the more likely they were taken up again after a phase of liberation during youth (Becker, 2014, p. 34). Furthermore, it was shown that habits have an higher impact on the behaviour of men then of women (Lin et al., 2017, p. 14).

Lin et al. (2017, p. 19) think that to transform residents' behavioural habits towards waste separation, mandatory regulations are needed.

2.1.2.1.10 Provided Information

Residents still often think that waste separation is not an easy task to do. Therefore, communities should improve their guidance to make waste separation easier by providing the right information (Dongliang et al., 2015, p. 9485). In a study of Rückert-John et al. (2021, p. 60) it was found that still 16% of the respondents do not

know how to separate their waste correctly. As well as convenience, information up to a certain point can be controlled by waste management organizations. The possibilities of communication are huge and differ in outcomes and reached individuals. (Becker, 2014, p. 7)

By analysing various studies, it was found that there exist two types of provided information: "abstract" and "concrete". While "abstract" information represents general recycling knowledge, "concrete" information concerns knowledge about how and what to recycle. Information about recycling has to be precise and should contain practical instructions like where to find collection points, what should be recycled and what not. (Miafodzyeva et al., 2013, p. 229)

a) Information sources depend on age

The source used for information depends strongly on the subject matter and the age of the individual (Rosenstiel et al., 2011, p. 1). Rosenstiel et al. (2011, p. 6) found in their survey that for people above the age of 40 newspapers are the main source for politics, community events, government activities and social services. For politics also television is used. Residents below the age of 40 use the Internet as main source for information about politics, community events, local government and social services. But also newspapers and television are used by this group of age.

b) Examples for special needs of information

Information for households with kerbside collection

For households that do not have access to a kerbside collection system or close-by recycling stations, information on how to reach recycling stations should be provided (Becker, 2014, p. 31).

Information about space efficient separation systems

As lack of space is one of the most important factors for not participating in waste separation, information and support on how to set up a space-efficient separation system should be provided (Becker, 2014, p. 31).

Information for immigrants

It was found that information at recycling stations for immigrants should mainly base on symbols rather than language. On the other hand, due to the desire of integration, immigrants might want to be treated like natives and learn the language. Therefore, a combination of symbols and easy native language might be best. Regarding general information about recycling, it was mentioned that personal meetings are more effective than information provided by waste management organizations. The reason for that might be, that many immigrants have left their country because of corrupt governments and do not trust anymore in "governmental information". (Becker, 2014, p. 37)

2.1.2.1.11 Social pressure

The second construct of "Theory of Reasoned Action" from Ajzen and Fishbein says that normative beliefs of a person create the motivation to be conform with these beliefs. The result is the subjective norm which influences the intention and lastly also the behaviour of an individual. (Brenncke, 2004, p. 11)

Subjective norm represents a person's perceptions of whether other individuals or society think one should engage in a certain behaviour (Mceachan et al., 2011, p. 2). Dongliang et al. (2015, p. 9485) found that subjective norms have a significant but low effect on waste separation intention. This means that social relations slightly promote or restrict a person's participation in waste separation. Most influential are families and communities.

However, in the studies examined by Brenncke (2004, p. 16) it could be shown that social norms which are transported by reference groups have a special influence on waste behaviour. Also values and especially collective value orientation which are transported by socialization and culture can have an influence on waste behaviour too.

For example, literature examined by Rückert-John et al. (2021, p. 59) has shown that social control in the living environment has an effect on waste behaviour. Respondents with contact to a lot of neighbours (5-10 and above 10) claim for many types of waste to separate them always. Participants who have contact with 2 - 4 neighbours are the biggest group and dedicate the average. Of the respondents which have only contact with only one neighbour less than the average claims to always separate. They state above-average to separate waste often or sometimes.

Also Shen et al. (2019, p. 12) found that if family, friends and colleagues are participating in waste sorting, young people are more motivated to classify waste due to herd mentality.

It was also found that behavioural intentions of a person strongly depend on this person's self-control abilities. These abilities can be strengthened by supervision and motivation within communities. (Dongliang et al., 2015, p. 9485)

a) Social pressure depends on external conditions

In the study of Stoeva and Alriksson (2017, p. 739), it was found that subjective norm does influence the Swedish participants of the study, while it has no effect on the behaviour of the Bulgarian participants. This may come from the different surrounding conditions in these two countries. Sweden has a long tradition of waste separation and developed a public expectation that individuals participate.

On the other hand, waste separation was implemented in Bulgaria in 2004. The lack of recycling experience and the disappointment about responsible institutions discouraged people to participate in waste separation. (Vasileva and Ivanova, 2014, p. 476)

Therefore, there is no public expectation that an individual should participate in waste separation. This can also be found in the results of the Bulgarian participants. Respondents with neutral results for subjective norm occurred twice as often in Bulgaria as in Sweden. (Stoeva and Alriksson, 2017, p. 739)

2.1.2.1.12 Trust in system

A study of Kossakowski (1999, p. 82) shows that people who do not separate reusable materials mostly have a lack of belief in reuse and separation. For non-recyclers the assumption can be made, that they know about the problems of the high amounts of produced waste but lack trust in the recycling system (Brenncke, 2004, p. 9). In the study of Rückert-John et al. (2021, p. 60) 17% of questioned people stated that separation does not make sense because everything would be poured together later anyway, when asked about the reasons for not participating in waste separation. This makes "lack of trust in the system" the second most important reason in this study.

On the other hand, also too much trust in the recycling process can affect waste separation behaviour negatively. More than 50% of the respondents in the study of Rückert-John et al. (2021, p. 63) think that the technological level of waste treatment plants in Germany is high enough to solve the waste problems. This can lead to the feeling in a population that their participation in waste separation is not needed.

2.1.2.2 Demographic drivers

Demographic drivers are mostly used to describe the environment in which recycling behaviour studies are executed. They also are relevant to show differences in the profiles of recyclers and non-recyclers. However, they are less relevant than techno-organisational and socio-psychological variables when it comes to explaining recycling behaviour. To determine the influence of demographic values there exist two common methods. One is the analysis of single demographic variables and their implications on recycling rates or on factors that influence recycling behaviour. This direct correlation shows very ambiguous results. There can be found studies that show correlations between demographic variables and recycling participation and some that do not. The picture gets less ambiguous when socio-demographics are related to influencing factors of recycling behaviour. (Becker, 2014, pp. 8–10)

The research of Becker (2014, 38-39) also found that socio-demographics can be used to characterize social groups, but only help to a certain degree to understand the behaviour

of these social groups. It can be said that social groups consist of individuals with a variety of demographic variables with no clear pattern.

However, especially in marketing and business administration demographics are used to study behaviour. Thereby individuals with similar characteristics are ascribed to groups with the assumption that individuals of the same group behave similarly. The British classification system ACORN which is used by the British waste and resources action program (WRAP) categorizes customers according to their demographic characteristics. This system is used by WRAP to generate knowledge about recyclers and non-recyclers. (Becker, 2014, p. 10)

2.1.2.2.1 Age

The willingness to participate in waste separation and in the end also actual behaviour may vary between different age groups in the population.

a) Group of younger people

For the group of young people in the study of Rückert-John et al. (2021, p. 84) the percentage which claims to separate waste always is for every type of waste below average. Furthermore, the percentage of people who say they do not separate waste at all is clearly above average for every type of waste. The main reason for not participating in waste separation of the younger people were:

- they do not know which waste goes into which container (32% in comparison to 16% in average),
- waste separation is too elaborate (22% in comparison to 12% in average),
- separation does not make sense because everything is poured together later anyway (22% in comparison to 17% in average),
- the containers are too full (20% in comparison to 22% in average),
- there is no space in the apartment to collect waste separately (20% in comparison to 16% in average),
- there is no possibility to separate waste in their housing complex (13% in comparison to 10% in average).

Regarding statements about the current waste situation the majority of the young people agree with the public opinion. However, also an above-average part of this milieu decline the problematic waste situation. For example, 26% of the respondents of this group thought that waste prevention is just a fashionable trend (in comparison to 15% in average). Also 2% think that media is presenting the plastic pollution in the oceans worse than it is (in comparison to 13% in average). Furthermore, 27% do not understand why the

waste topic is discussed so much (in comparison to 20% in average). (Rückert-John et al., 2021, pp. 84–85)

These results show that a big part of the separation behaviour can be explained by inconvenience and bad comprehensibility of the separation system. Therefore, Lin et al. (2017, p. 15)suggested that providing adequate and convenient separation facilities and waste collection services could be effective to promote young people's effort to participate in waste separation.

b) Group of middle-aged adults

Saphores et al. (2006, p. 189) found that middle-aged adults between 36 and 65 years old are the most willing group when it comes to recycling, although, they have jobs and families. Also Rückert-John et al. (2021, p. 59) found that older residents separate more consistently than younger ones.

Above-average many respondents of the groups 50 - 59 years of age and 60 - 65 years of age state that they always separate waste. This statement applies to all types of waste. The middle-aged group is affected by their family. They want to be a good example for other family members or worry about the health situation of the whole family. But they are also strongly committed to their own past experiences regarding waste separation. (Lin et al., 2017, p. 15)

c) Group of senior residents

The results of Lin et al. (2017, p. 15) show that the gap between intention and behaviour is more likely to be found in the senior-aged group. Older people may have the right intentions towards waste behaviour but might not perform the necessary action in the end. The study of Meneses and Palacio (2005, p. 844) showed that the further the age of a residents is away from the age of the working population (31-50) the more barriers an individual faces to participate in recycling.

d) Children

Although younger children might not be able to read, studies of Klineberg et al. (1998) and Liefländer & Bogner (2014) showed that this group has a high potential in developing pro-recycling attitudes. This should motivate officials to target particularly this group with their initiatives (Becker, 2014, p. 16).

This way a society which is aware of their environmental responsibility and that acts in environmentally friendly ways could be grown.

2.1.2.2.2 Employment status

The employment status affects people not only in time they have left during the day, but also in housing situation, the social environment and the motivation to overcome obstacles. In the following paragraphs, two important groups which both do not work were analysed. The group of employed residents was not separately discussed in the found literature. It is assumed that this group was seen as represented by the general average of a population. The group of retired residents is included in the age-group “senior-residents”.

a) Unemployed residents

The group of unemployed residents has more time to structure the household and participate in recycling. Their participation possibly can be explained by the fact that recycling is a relatively easy way to participate in environmental care. It is seen as an opportunity to participate in society without consuming a lot of time and effort. However, inactivity can be a factor which defeats the argument of having enough time. During this study it could be seen that unemployed residents possess good knowledge about recycling. A possible conclusion is, that this group especially needs motivational support. (Becker, 2014, p. 34)

b) Students

Students are mainly living in student accommodations. These usually provide space for the separate collection of recyclables in shared kitchens. As this group does not want to spend money on waste bags and containments for recyclables, space-efficient recycling equipment should be provided. As the focus of students mostly lies on other issues (time, money, social activities, school) it could be more important to provide information on how to recycle than why to recycle. Because recycling behaviour is very transparent in this type of housing, it is important to keep the moral high. All the residents sharing a facility should participate in recycling. For this frequent educational meetings about recycling could be an option. Addressing an influential person of the social group directly, has also been found as effective for promoting recycling. Also this group could be reached via their interest groups and associations. Furthermore, they might also be motivated by economic incentives like free lunch or cinema tickets. (Becker, 2014, p. 33)

2.1.2.2.3 Family situation

Family situation describes whether or not a person is living with a partner and if children are living in the household. This can affect the attitude towards recycling, the access to separation-related knowledge and of course the type and amount of produced waste. The following paragraphs focus on younger families and the influence of children, as older

families rather belong to the average of the population. Couples and single-living males are discussed in the point “Gender”.

a) Young families

Usually young families can afford their own house / flat, value the health and safety of their children very much and because of that are aware of environmental issues. The willingness to decrease the environmental impact of their activities makes them an interesting group for waste managing organizations. They might be interested in testing new approaches and engaging in neighbourhood activities. This group often shows a very positive attitude towards recycling. Information about how and why to recycle are both appreciated. They also are the only group which dispose napkins, glass containments for baby food and other baby products. Therefore, they could be directly addressed in how to handle and reduce this kind of waste. (Becker, 2014, p. 36)

b) The influence of children

Children that receive education about recycling in kindergarten act as ambassadors for recycling in their own homes. They are eager to apply their gained knowledge and educate and push their parents towards recycling activities. (Becker, 2014, p. 35) This is consent with a study of Asensio et al. (2015, p. 512) which found that adults with children perform better in pro-environmental programs. Due to the influence of children in their families it is seen as important to educate young people in school about waste sorting and on this way influence their families' subjective norm (Dongliang et al., 2015, p. 9485).

2.1.2.2.4 Gender

Gender influences the behaviour of people in many ways. Different ways of thinking and differently distributed importance of values lead to different actions. Therefore, also waste separation behaviour to a certain part depends on the gender of a person.

It was found that male residents have weaker pro-environmental attitudes than their female counterparts. Women seem to have a higher concern about the environment than men. They also tend to take more responsibility regarding waste separation at home than men do. Regarding the kind of message needed by persons according to their gender, it could be found that information on how to recycle are more interesting to women than to men. (Becker, 2014, p. 36)

Thus, it was observed that the actual waste sorting behaviour is influenced by gender. In summary, it can be said that women tend to separate more consequently than men. This can be seen in the percentages of the persons which claim to always separate. Some

examples of different types of wastes can be seen below (Rückert-John et al., 2021, p. 60):

- biological waste (55% men, 61% women),
- packaging waste (72% men, 82% women),
- paper (78% men, 84% women),
- glass (74% men, 78% women),
- etc.

a) Single living males under 30

Especially single living males under 30 often lack structure, habit and motivation to recycle. Recycling does not seem to be an important issue and without any economic incentives, effort of participating in waste separation appears not to be rewarding. This group also mainly lives in urban areas, which means usually a car is not needed. Due to that, further located collection points are mostly not visited. Furthermore, there is no group that directly influences single living males of this age which makes them a group of individuals that is hard to reach. They were also found to be more likely willing to pay to get relieved from recycling activities. On the other hand, this group shows a high competitive nature. Controlling their behaviour and report their achievements in a way that they are visible for others could activate their competitive nature. The aspect of control is clearly relevant to this group. (Becker, 2014, p. 36)

b) Mixed households

In households with mixed genders women usually feel more responsible to separate waste. It could be that males feel more comfortable with taking out the waste to the recycling station. If this was true, information about separation should be more appealing to women, while the design of recycling stations should be more appealing to men. (Becker, 2014, p. 36)

c) Motivating men to participate in waste separation

It is necessary to engage men more in recycling activities and educate them more about the relevance of recycling (Becker, 2014, p. 36). According to the results found by Lin et al. (2017, p. 14) better participation of males in waste separation could be achieved by a higher, more intensive publicity regarding separation knowledge and values. Furthermore, more sufficient and convenient collection facilities and services should be provided

2.1.2.2.5 Heritage and Culture

Heritage and culture affect people's behaviour in many ways. One of them is what kind of waste they produce and how they handle it. Another is how they assign household activities. Also governmental regulations and the control of behaviour is perceived differently in different cultures.

a) Hospitality and food

In many cultures food and hospitality play a big role. Therefore, these cultures often have a higher need to dispose food waste. Information about equipment and how to separate and dispose food waste correctly should be provided. (Becker, 2014, p. 37)

b) The role of females

Many cultures assign household activities to the females in the household. These females could be reached via women's organizations of their cultural background. In this way, education about how to recycle could be provided to them. (Becker, 2014, p. 37)

c) Perception of control

Swedish residents tend to decline control of their recycling activities. In Malmö households which have received a negative feedback about their food waste collection, became dissatisfied about the actions of the waste management organization. This shows that control about activities that are felt to be private is not welcomed in the Swedish society. However, in other systems people tend to obey governments without questioning the rules and guidelines. Therefore, knowledge about cultural differences and the reaction of different groups on measures, feedback and information is essential for designing effective measures to increase participation in recycling. (Becker, 2014, p. 38)

2.1.2.2.6 Income

The driver "income" includes every level of income and in general wealth of a person. It affects people's value-distribution and perspectives, their available time, the availability of commodities, the consumed goods and therefore also their produced waste. Furthermore, it affects a person's type of housing and on this way the collection system they participate in. Most of the studies that were examined by Miafodzyeva et al. (2013, p. 224) found a relation between income and recycling behaviour. However, the different findings show, that this relation is not consistent.

a) Wealthier households

Participation in recycling

In the upper milieu a high acceptance and therefore, also an implicitness about waste separation can be found (Rückert-John et al., 2021, p. 70). Kurz et al. (2007, p. 383) found that participation in recycling is highest in areas with a high level of income. These

results are consistent with the results of other studies (Domina and Koch, 2002, Owens et al., 2002), which too report a higher level of participation in areas with middle- to upper level of income (Miafodzyeva et al., 2013, p. 224). On the other hand, Hage and Söderholm (2008, p. 1726) found that a higher level of income does not necessarily lead to a higher recycling participation. Their point is, that opportunity costs such as time must be considered. According to this construct, costs of recycling increase with higher income.

Production of waste

Income relates to amount and type of generated waste. Families with a higher level of income tend to dispose more food than households with lower income. This fact could also be confirmed by a study of the WRAP (Bridgwater and Parfitt, 2009, p. 4). They also exchange their furniture more frequently. Residents of single-household dwelling with garden can often dispose food waste into a house compost. For that support on information about composting should be provided. Furthermore, higher income households should be informed about possibilities how to avoid food waste. If an own compost is not available or possible, food waste separation could be enhanced by providing the right equipment to handle food waste. This support could include extra bins for food waste or food waste bags. (Becker, 2014, p. 31)

Higher convenience and more space

As wealthier people have a higher capability to buy a car, they are less dependent on close collection points (Becker, 2014, p. 15). And also due to bigger houses / apartments, lack of space for waste separation seems to be less of a problem for wealthier people (Becker, 2014, p. 31). This finding could also be confirmed by Rückert-John et al. (2021, p. 69). The authors found that the argument that there is not enough space in the flat for waste separation comes up less among wealthier residents (12 % in comparison to 16% in average). Furthermore, it was found that in wealthier regions full containers are less of a problem (13 % in comparison to 22 % in average).

Trust in system and perceived responsibility

Regarding the question about the technological level of waste treatment plants, there exists an above average agreement in this group of people that this level is high enough to solve waste problems (48 % in comparison to 36 % in average). This shows that there is confidence in the technical solvability of the waste problem. For the upper class it is also clear that politics, producers and the commerce sector have to do something against waste problems. (Rückert-John et al., 2021, pp. 69–70)

This trust in the system and lack of own perceived responsibility might lead to a lower participation in waste separation.

Educational measures

Individuals which can afford to buy or rent a house are more common to have the intention to stay in one place a greater amount of time. Due to that, education measures for this group could be more sustainable than in housing environments with high fluctuation. These households are most likely presented by a group of over 30 year olds, with higher education which consume more reflected news. They also tend to have professional roles with higher responsibilities. Therefore, they are more likely to be reached by messages which give them the feeling of responsibility. Furthermore, it is assumed that this group possesses a higher level of environmental education. (Becker, 2014, p. 31)

b) Middle class households

The middle class mainstream shows following characteristics when it comes to waste separation:

- medium amount of possibilities of waste separation in a collect system,
- high separation of recyclable materials,
- low volume of residual waste and high volume of recyclable materials,
- very low share of residual waste and medium share of recyclable materials in the total generated waste,
- medium rate of separation mistakes in the residual waste and for recyclable materials,
- medium share of residual waste and medium share of recyclable material in the residual waste,
- high amount of correctly separated recyclable materials.

(Rückert-John et al., 2021, p. 152)

In the study of Rückert-John et al. (2021, p. 73) only 10 % of the middle-class mainstream (in comparison to 16 % in average) do not know which waste goes in which container. But 25 % of this group (in comparison to 22 % in average) state that the containers are mostly full. Only 42% of this group (in comparison to 50 % in average) think that it is government's responsibility to reduce waste in Germany. Also, only 54 % (in comparison to 60 % in average) think that packaging-producers and the commerce sector is responsible for waste reduction and separation.

c) Lower-income households

According to Kurz et al. (2007, p. 383) low income areas show the lowest participation in recycling. These households tend to have their focus more on financial issues than on recycling. This group includes, for example, immigrants with low education and the desire for safety, students and residents with lower paid jobs. These residents are more likely to

live in multi-occupancy housing situations with less space available. Therefore, information on how to collect recyclables in a space-saving way is needed. Furthermore, income affects the type of consumed food. This group tends to consume more pre-made, packaged food. Therefore, they present a target group for promotion of plastics recycling. On the other hand, they produce less paper waste due to a lower consumption of newspapers and also less food waste due to the lower use of fresh vegetables and fruits. (Becker, 2014, pp. 32–33)

Regarding the available space for separation in their flats, 21 % of the respondents of this milieu in the study of Rückert-John et al. (2021, p. 77) said that there is not enough space for separate waste collection (in comparison to 16 % in average). Interesting is, that only 9 % of the questioned people of this group stated that they do not know how to separate their waste correctly (in comparison to 16% in average).

2.1.2.2.7 Level of education

In almost two third of the literature that was examined by Miafodzyeva et al. (2013, pp. 224–225), level of education was mentioned. However, the results of its influence are not consistent. There have been reported correlations with years of schooling and higher education in numerous studies, but a similar amount of studies did not find these correlations.

For example, Dongliang et al. (2015, p. 9485) found that respondents with different educational levels showed different separation behaviour. The group of undergraduates showed more positive separation behaviour than all the other groups. Saphores et al. (2006, p. 195) found that respondents without college education showed lower willingness to participate in recycling. Rückert-John et al. (2021, p. 63) found that respondents with university degree are more likely to not agree with the statement "I am glad that my waste gets collected regularly, but I do not care any further". 48 % of the group of respondents with university degree reject the before mentioned statement, while of the overall average only 39 % reject it. 71 % of the participants with "Abitur" do not think that the waste problems can be solved by technological solutions. In comparison only 61 % of all respondents think like that.

On the other hand, studies in different cultural regions such as America, Spain or Iran have already shown that a higher education level does not necessarily lead to a stronger intention nor a better performance in waste separation. A reason for that could be that waste separation need specific environmental knowledge which is not received by usual degree education programs. (Lin et al., 2017, p. 13)

2.1.2.2.8 Location (urban, suburban, rural)

The factor “location” refers to the location of the residence of waste producers. Rural, suburban, and urban areas often do not only differ in collection systems. They also differ in socialisation aspects, learned behaviour, developed values and ethics.

In comparison to urban residents, rural residents have created informal norms and ethics which restrain their individual behaviours. On the other hand, urban residents are living relatively independent and tend to make more independent decisions. The conclusion is that the norms and ethics of rural communities could be used to influence the people's behaviour. Furthermore, these soft moral obligations should be transformed in legally binding law and regulations. The intention towards waste sorting of the young rural population could be targeted by environmental protection organizations. (Shen et al., 2019, p. 13)

2.1.2.2.9 Personal barriers

By barriers, physical barriers due to disabilities or high age are meant. They often make life harder for people or even prevent them from executing certain actions, even if the intention is there. Therefore, these people are reliant on the help of others and the accommodation of their surroundings.

For example, disabled residents could be discouraged by longer distances so collection points. Heavy waste could especially be a problem for people with reduced mobility. It could be difficult for them to use the currently provided infrastructure as the containers are designed for average grown up individuals. Lifting the lid, carrying waste and reaching up to the higher located openings could be a problem for people who cannot be ascribed to this group. (Becker, 2014, p. 16)

2.1.2.2.10 Political preferences

Political preferences can be a predictor on the attitude of a person for many different topics. Mostly it is differentiated between left wing supporters, right wing supporters and supporters of the political centre.

According to Kals (1996, p. 26) the political orientation is one of the main sociodemographic aspects which are evaluated in environmental literature. For example, the study of Buchholz (2000, pp. 167–168) shows that people in Germany which participate rather often in waste prevention, waste reduction and waste sorting are mostly voting for "Bündnis 90 / die Grünen". On the other hand, people who rather rarely participate in these actions are mostly voting for “Christilich Demokratische Union

Deutschlands" (CDU), "Freie Demokratische Partei" (FDP) or "Sozialdemokratische Partei Deutschlands" (SPD).

2.1.2.2.11 Social status

In the year 2000 Stern (2000, p. 417) added personal capabilities to his theory of internal and external factors influencing environmental behaviour. These personal capabilities include social status and power.

Social status in our society can often be associated with positions in a company or in public services. The study of Becker (2014, p. 32) shows that people with higher responsibilities in their jobs are more likely to be reached by messages which give them the feeling of responsibility for contribution to society and welfare, and thus, could lead to better source segregation practices.

2.1.2.2.12 Type of dwelling

This variable is less frequently found in the literature that was examined by Miafodzyeva et al. (2013, p. 225). However, it is one which shows the most homogeneous results. Studies which have examined this aspect found a significant relation between the type of dwelling and recycling behaviour.

a) Type of dwelling determines the collection system

The housing situation is determinant in which collection system residents participate. In Sweden houses / villas and multi-occupancy households enjoy the availability of central collection points. However, while they also have private collection systems, only 50% of the multi-occupancy houses have collection points which belong to their residency. (Becker, 2014, p. 15). On the other hand, this type of housing most often has close-by recycling stations which provide containers for all recycling fractions. Therefore, the level of convenience is very high. However, these stations are used by many households which increases the risk of untidiness and messiness because in this anonymous environment wrongly separated waste and littering stays undetected. (Becker, 2014, p. 33)

b) Lack of space as reason for no participating in waste separation

In a study about reasons for not participating in a kerbside recycling scheme it was found that lack of space for additional bins is one of the main reasons why people choose to not participate in the collection scheme. (McDonald and Oates, 2003, p. 375)

Also Rückert-John et al. (2021, p. 60) identified lack of space as an important reason. 16 % of the people who were asked about their reasons for not participating in recycling mentioned that there was no space in their apartment for separate waste collection.

In addition, most of the studies that were examined by Miafodzyeva et al. (2013, p. 225) found that residents living in single-family private houses participate more in recycling than families in multiple-family apartment dwellings. This finding can again be explained by the fact that in single-family houses have more space available for the separate collection of waste than in multiple-family houses. (Hage et al., 2009, p. 159)

Becker (2014, p. 7) also mentions appropriate storage space in the household as a part of convenience, which strongly influences waste separation behaviour.

c) Importance of appearance and tidiness

Private households which use their own collection place and potentially central recycling stations, tend to care more about the tidiness and the function of the systems. Households that share recycling facilities were found to be less interested in these two factors. (Becker, 2014, p. 15)

2.2 Literature research on MCDA and AHP

The Analytic Hierarchy Process (AHP) is a method to execute Multi-Criteria Decision Analysis (MCDA). In the present work it is used to weight the drivers which influence waste sorting behaviour. Therefore, in this section MCDA in general and the AHP explicitly are explained.

2.2.1 Process of the literature research

For this literature research relevant papers were obtained from Google Scholar, the online library of the University of Leoben and Science Direct. By using the keywords “MCDA”, “AHP” and “pairwise comparison” relevant studies could be found easily. Of the found literature the most relevant information for this study has been summarized in the following sections. General information about MCDA is described, while the AHP is explained more detailed. The reason for that is, that for analysing the survey data the pairwise comparison method is used. This method is an important part of the AHP. However, no complete MCDA was executed and the present study marks as an initial step for the future MCDA studies.

2.2.2 Results for the Multi-Criteria Decision Analysis (MCDA)

Multi-Criteria Decision Analysis or MCDA (also known as Multi-Attribute Decision Analysis or MADA) can be found in public and private sector organisations. On the one hand it can be seen as an approach and on the other hand, as a set of techniques. MCDA is a process to solve complex problems that are characterised by monetary and non-monetary objectives. Therefore, the problem is broken down into more manageable pieces. This makes it easier to allocate data and make initial judgments. These pieces are then reassembled to a coherent overall picture. The goal is to provide a hierarchy of options, from the most preferred to the least preferred option. These options can differ in the extent of achieving different objectives. As a set of techniques, MCDA offers different options to fragment a complex problem, to measure the extent to which options fulfil objectives, to weight objectives and to reassemble the pieces. (Department for Communities and Local Government, 2009, p. 46)

2.2.2.1 Theorems of MCDA

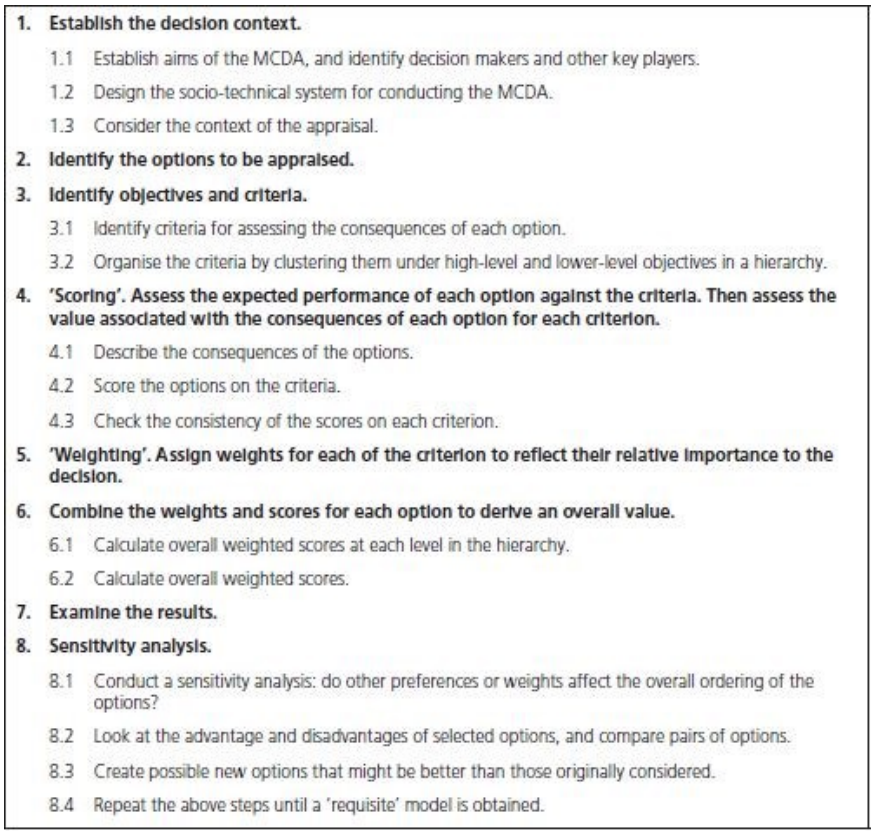
The main assumption in decision theory is that decision makers want to be coherent in their decisions. This means they would not make decisions that are contradictory to each other. The decision theory has expanded this idea of consistency of preference and has developed simple principles of coherent preferences, such as the principle of transitivity. This principle says that if option A is preferred to option B, and B is preferred to C, then A should be preferred to C. By implementing these rather simple principles as axioms it is possible to prove non-obvious theorems which can be used as guidelines to decision making:

1. The first theorem proves the existence of probabilities:
   probabilities are numbers that express the likelihood of possibly occurring consequences
2. The second theorem shows the existence of utilities:
   utilities are numbers which express the subjective value of the consequences
3. The third theorem provides a guide to making decisions:
   one should choose the actions which lead to the greatest sum of probability-weighted utilities (called expected utilities)

In practice MCDA is used to develop coherent preferences, which then allow a decision maker to make a more confident decision. However, MCDA is not just a technical process. Its successful implementation depends strongly on effectively designing social processes according to which the analysis is structured and conducted. (Department for Communities and Local Government, 2009, pp. 46–47)

2.2.2.2 Steps of a MCDA Process

Figure 1 shows detailed steps to correctly execute an MCDA.



1. **Establish the decision context.**
   - 1.1 Establish aims of the MCDA, and identify decision makers and other key players.
   - 1.2 Design the socio-technical system for conducting the MCDA.
   - 1.3 Consider the context of the appraisal.
2. **Identify the options to be appraised.**
3. **Identify objectives and criteria.**
   - 3.1 Identify criteria for assessing the consequences of each option.
   - 3.2 Organise the criteria by clustering them under high-level and lower-level objectives in a hierarchy.
4. **'Scoring'. Assess the expected performance of each option against the criteria. Then assess the value associated with the consequences of each option for each criterion.**
   - 4.1 Describe the consequences of the options.
   - 4.2 Score the options on the criteria.
   - 4.3 Check the consistency of the scores on each criterion.
5. **'Weighting'. Assign weights for each of the criterion to reflect their relative importance to the decision.**
6. **Combine the weights and scores for each option to derive an overall value.**
   - 6.1 Calculate overall weighted scores at each level in the hierarchy.
   - 6.2 Calculate overall weighted scores.
7. **Examine the results.**
8. **Sensitivity analysis.**
   - 8.1 Conduct a sensitivity analysis: do other preferences or weights affect the overall ordering of the options?
   - 8.2 Look at the advantage and disadvantages of selected options, and compare pairs of options.
   - 8.3 Create possible new options that might be better than those originally considered.
   - 8.4 Repeat the above steps until a 'requisite' model is obtained.

Figure 1: Detailed steps of the MCDA (Department for Communities and Local Government, 2009, p. 50)

2.2.3 Results for the Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process is an approach for multicriteria decision making in which the different factors are arranged in a hierarchic structure. This structure consists of an overall goal, criteria, sub criteria and alternatives on successive levels. (Saaty, 1990, p. 9) The main purpose of the Analytic Hierarchy Process is to develop relative scales out of judgment or data from a standard scale. The judgments are made by pairwise comparison of elements on a single property without taking other properties or elements into concern. These comparisons can sometimes also be made on the basis of standards gained through experience or training. (Saaty, 1990, p. 12)

2.2.3.1 The process

"To make a decision in an organised way to generate priorities we need to decompose the decision into the following steps.

1. *Define the problem and determine the kind of knowledge sought.*
2. *Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent element depend) to the lowest level (which usually is a set of the alternatives).*
3. *Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.*
4. *Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained."*

(Saaty, 2008, p. 85)

2.2.3.1.1 Developing a hierarchical structure

In the AHP, the hierarchy serves as a graphical formalism to combine alternatives, criteria and goals and represents the problem in an intuitive way. It compounds of:

1. the goal,
2. the alternatives,
3. the criteria,
4. and the relations between goal, criteria and alternatives.

(Brunelli, 2015, p. 11)

When it comes to structuring a problem, the hierarchy has to include enough detail to:

1. present the problem as extensive as possible, but not so extensive that the sensitivity for changes in different elements gets lost
2. take the surrounding environment into account
3. spot issues and aspects that could contribute to a solution
4. identify stakeholders of the topic

Arranging goals, aspects, issues and stakeholders in a hierarchy provides an overview over the complex relations within a topic. Furthermore, it helps the decision maker to find out if issues on different levels have the same order of magnitude. However, a hierarchy does not have to be complete. This means, an element at a given level does not necessarily have to be an attribute (or criterion) for all the elements of the level below. Each level may represent a different perspective of the problem. A decision maker can also eliminate or add levels and elements if he sees it as necessary to clarify priorities or sharpen focus. However, it is important that the criteria of the alternatives and the alternatives itself are layered gradually in the hierarchy, so that they can be meaningfully compared to each other. (Saaty, 1990, pp. 9–10)

Figure 2 shows a scheme of how such a hierarchy could look like.

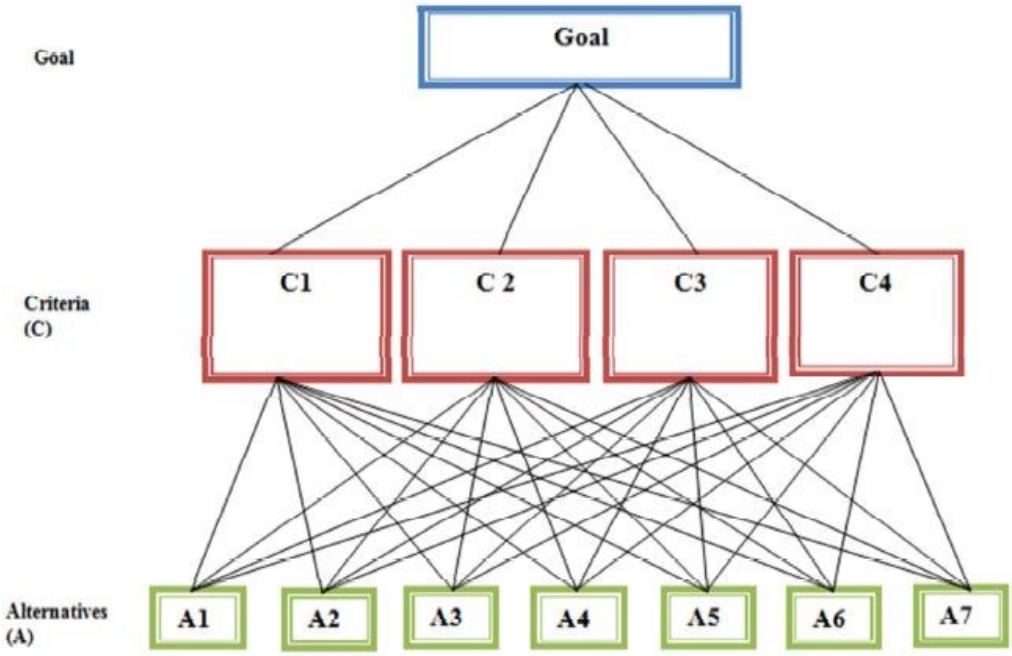


Figure 2: Hierarchy in the Analytical Hierarchy Process (Khaira and Dwivedi, 2018, p. 4031)

2.2.3.1.2 Pairwise comparison

Pairwise comparison is one of the two major parts of the AHP. It is used to weight the identified criteria. The first step of determining the weights includes the creation of a judgement matrix based on the judgement about the relative importance of each criterion according to a scale from 1 to 9. In the second step the weights are calculated and a consistency check is done to see if the made comparison is reasonable. (Shao et al., 2020, p. 387)

The expert has to consider a set of criteria $C=(c_1,...., c_m)$ during the decision making process. These criteria represent characteristics which make an alternative preferable to another in respect to a given goal. (Brunelli, 2015, p. 11)

Pairwise comparison allows a decision maker to consider two alternatives at a time. The original problem is decomposed into many smaller sub-problems which are easier to deal with. These pairwise comparisons are structured in a matrix $A=(a_{ij})_{n \times n}$. (Brunelli, 2015, pp. 9–10)

Equation 1: Pairwise comparison matrix A with entries a_{ij} as ratio between the weights of two elements (Brunelli, 2015, p. 10)

$$\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{pmatrix}$$

Hereby, the entry a_{ij} expresses the ratio of the weight ω_i of element x_i and the weight ω_j of element x_j. (Brunelli, 2015, p. 10)

Equation 2: a_{ij} as ratio between the weights w_i and w_j (Brunelli, 2015, p. 10)

$$a_{ij} \approx \frac{w_i}{w_j} \quad \forall i, j.$$

If the entries represent the ratios between the weights, the matrix can be shown in the following way: (Brunelli, 2015, p. 10)

Equation 3: Pairwise comparison matrix A with relations of weights ω_i (Brunelli, 2015, p. 10)

$$\mathbf{A} = (w_i/w_j)_{n\times n} = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix}.$$

When looking at the before mentioned matrices a reciprocity of $a_{ij}=1/a_{ji}$ can be recognized. Therefore, A can be rewritten: (Brunelli, 2015, p. 10)

Equation 4: Pairwise comparison matrix A with reciprocal values (Brunelli, 2015, p. 10)

$$\mathbf{A} = \begin{pmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{pmatrix}.$$

Scale of comparison

To compare the different elements, a scale of numbers that indicate how important one element is in comparison to another element(Saaty, 2008, p. 85). This scale can be seen in table 4.

Table 4: Scale of preference for the comparison of two elements (adapted from Saaty) [50, p. 407]

Intensity of Importance	*Definition*	*Explanation*
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity *i* has one of the above non-zero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*	A reasonable assumption
1.1–1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

2.2.3.1.3 Gaining the priority vector

An essential step of the AHP is the derivation of a priority vector w of each pairwise comparison matrix A. If each entry a_{ij} is exactly the ration between two weights ω_{ij}, all the columns of the matrix A are proportional, and the priority vector w is equal to every normalized column of A. In this case the information of the matrix A can be synthesized in the priority vector w without loss of information. But if the entries a_{ij} are not exactly the ratios between two weights ω_{ij} there is no priority vector w which perfectly synthesizes the information of the matrix A. However, the Analytic Hierarchy Process does not work without priority vectors. Therefore, it is necessary to obtain a "good" priority vector. The most popular method for this is the eigenvector method. According to this method the priority vector is the principal eigenvector of the matrix A.

By multiplying a matrix A whose entries a_{ij} are exactly defined as ratios between two weights ω_{ij} with the priority vector w, one obtains: (Brunelli, 2015, pp. 21–22)

Equation 5: Eigenvector method: connection between matrix A, eigenvalue n and eigenvector w (Brunelli, 2015, p. 22)

$$\mathbf{Aw} = \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix} \begin{pmatrix} w_1 \\ \vdots \\ w_n \end{pmatrix} = \begin{pmatrix} nw_1 \\ \vdots \\ nw_n \end{pmatrix} = n\mathbf{w}.$$

From linear algebra it is known that the formulation Aw = nw implies that n is an eigenvalue and w is an eigenvector of A. Knowing that the other eigenvalue of A is 0 and has multiplicity (n-1), n has to be the largest eigenvalue of A. If the entries a_{ij} are ratios between two weights (ω_i / ω_i) then the weight vector is the eigenvector of A belonging to the eigenvalue n. *"Saaty proposed to extend this result to all pairwise comparison matrices by replacing n with the more generic maximum eigenvalue λ_{mas} of A. That is vector w can be obtained from any pairwise comparison matrix A as the solution of the following equation system where λ_{max} is the maximum eigenvalue of A, and 1=(1,..., 1)^T.* (Brunelli, 2015, pp. 22–23)

Equation 6: Equation system to obtain the eigenvector w (Brunelli, 2015, p. 22)

$$\begin{cases} \mathbf{Aw} = \lambda_{\max}\mathbf{w} \\ \mathbf{w}^T\mathbf{1} = 1 \end{cases}$$

2.2.3.1.4 Checking for consistency

If a decision maker were able to execute perfectly consistent pairwise comparisons the following condition would hold: (Brunelli, 2015, p. 26)

Equation 7: Transitivity condition of a consistent matrix [47, p. 26]

$$a_{ik} = a_{ij}a_{jk} \quad \forall i, j, k\,,$$

To make it better understandable, the figure 3 shows consistent and inconsistent transitivity:

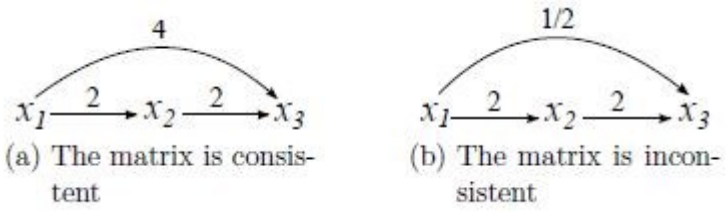


Figure 3: Diagrams of a consistent and an inconsistent transitivity

"A matrix for which this transitivity condition holds is called consistent (Brunelli, 2015, p. 26)." Being consistent in building a pairwise comparison matrix is rarely possible because many factors can lead to inconsistencies. However, consistency is a desirable state, as an inconsistent matrix could indicate the incapacity or inexperience of the decision maker in this particular field. Inconsistency can be seen as a gradual notion and can be of different extent and gravity. As a matrix should depart as less as possible form the condition of transitivity, various inconsistency indices have been developed to measure this deviation. Consistency can be formulated in various equivalent ways. One of them is that the maximum eigenvalue (λ_{max}) of a consistent pairwise comparison matrix (A) is equal to the number of compared elements (n). Therefore, Saaty (1977) proposed the Consistency Index (CI) to measure the level of inconsistency of a pairwise comparison matrix: (Brunelli, 2015, pp. 27–28)

Equation 8: Consistency Index of a pairwise comparison matrix (Brunelli, 2015, p. 28)

$$CI(\mathbf{A}) = \frac{\lambda_{\max} - n}{n - 1}.$$

Consistency Ratio (CR) was implemented as a rescaled version of CI. CR can be calculated by dividing CI through a Random Index (RI_n). RI_n is dependent on n and represents an estimation of the average CI from a large set of randomly generated matrices with size n. (Brunelli, 2015, p. 28)

Equation 9: Consistency Ratio of a pairwise comparison matrix (Brunelli, 2015, p. 28)

$$CR(\mathbf{A}) = \frac{CI(\mathbf{A})}{RI_n}$$

Saaty (1980) states that in practice matrices with a value for CR below or equal to 0.1 should be accepted and matrices with a value for CR greater than 0.1 should be rejected. A value of CR=0.1 means that the pairwise comparisons of the matrix are 10% as inconsistent as if they had been assigned randomly. (Brunelli, 2015, p. 28) This means the

pairwise comparisons for matrices with a consistency ratio equal or above 0.1 have to be adjusted.

The values for the Random Index RI_n can be taken out of table 5.

Table 5: : Random indices (RI) in dependcence of the amount (n) of compared elements (Alonso and Lamata, 2006, p. 450)

n	**RI (n)**
3	0.5247
4	0.8816
5	1.1086
6	1.2479
7	1.3417
8	1.4057
9	1.4499
10	1.4854
11	1.5140
12	1.5365
13	1.5551
14	1.5713
15	1.5838

2.2.3.2 Applications of the Analytic Hierarchy Process and pairwise comparison

As the main focus of this thesis is on weighting the factors (seen as criteria) based on their influence on waste separation behaviour, in this section a few examples for the successful application of the pairwise comparison matrix are shown. These examples also underline the advantages of the Analytic Hierarchy Process.

2.2.3.2.1 Finding renovation solutions for buildings

Because most of the existing approaches in finding renovation solutions for buildings do not take multiple stakeholder into account, Amorocho and Hartmann (2022, p. 1) started a new approach on this topic where they applied a more complete Mulit-criteria decision making (MCDM) framework and amongst others the pairwise comparison method. To illustrate and validate the framework two case studies about a building in Spain have been used. Using the MCDM and the pairwise comparison enabled the participation of multiple stakeholders in the process of setting objectives and criteria, evaluating the alternatives and weighting the criteria and the performance of the alternatives. This allows discussions and a more complete analysis of the renovation alternatives. A shared view of the renovation and a final ranking of the alternatives were obtained.

2.2.3.2.2 Choosing military camouflage patterns

In his work about military camouflage Baumbach (2012, pp. 95–96) mentions the use of the AHP and therefore, also of the pairwise comparison process in relation to the rating of different camouflage patterns. The author sees the main advantage of the pairwise comparison of the AHP that observers stated how much better one pattern is than the other. This lead to a result that is expressed on a scale from 0 to 100, while the also used Law of Comparative Judgement delivers values on an open ended scale, which makes comparisons difficult. As another reason the possibility of calculating a consistency ratio and filtering out inconsistent data is mentioned.

2.2.3.2.3 Improving downtimes in a hydroelectric powerplant

The study of Can Özcan et al. (2017, p. 1410) focuses on finding ideal maintenance strategies for different equipment of a hydroelectric powerplant by applying proposed goal programming (GP) in combination with the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and the Analytic Hierarchy Process. The Analytic Hierarchy Process was used to weight the criteria by which the most important parts of the powerplant were chosen. It was also applied to determine the priorities of the different maintenance alternatives. By the application of the determined, proper maintenance strategies the downtimes of the powerplant could be improved by 77%.

2.2.3.2.4 Selection of renewable energy sites

The paper of Shao et al. (2020, p. 387) examines 85 papers published between 2001 and 2018 which applied Multi-Criteria Decision Making (MCDM) for the selection of renewable energy sites. Out of these 85 papers 46 applied the regular Analytic Hierarchy Process and therefore, also executed the pairwise comparison to weight their criteria.

3 Practical part

This part includes three different weighting processes of the drivers that were found during literature research. In the first step the factors were presented to experts which weighted the factors according to their knowledge and experience. In the second step the perception of these factors of parts of the populations of Barcelona and Leoben were evaluated. After this these three weightings are compared and discussed. The results of this process can be found in this chapter.

3.1 Expert ranking

The expert ranking provides insight into how experts of the waste management sector and experts of behavioural studies perceive waste sorting behaviour and by which drivers they think this behaviour is influenced the most. However, the participating experts can only provide their opinion, based on their knowledge & experience. This means, this ranking provides only an insight into a way more complex topic and could hardly be taken as an absolute. Nevertheless, due to the diversity and the years of experience of the participating experts their ranking is still seen as very valuable and participates to the understanding of waste sorting behaviour.

3.1.1 Building of the survey

To acquire the rankings of the experts a survey-form was built in word. It contains a short introduction to the thesis in which the purpose of the thesis and the reason why the participation of the experts is needed are explained. Furthermore, it contains a detailed explanation of the ranking process. In part A of the ranking process, the drivers are presented in two categories. Category one is named “non-demographic drivers” and contains 12 drivers which apply to this label. Category two is named “demographic drivers” and also contains 12 drivers which apply to this category. The drivers are presented in form of a table which consists of the columns “Driver”, “Rank” and “Short explanation of the ranking”. The drivers were already filled in into the first column, the other two columns were to be filled in by the experts. In each table two empty rows were added so that the experts had the possibility to add important drivers which they thought were missing. In part B of the ranking process, the experts were asked to rate the categories in percent based on the perceived influence on waste sorting behaviour. The last two pages of the document contain a short description of the drivers, which again were divided into the above-mentioned categories. At the end of the document the experts were offered the possibility to leave a comment or a suggestion about the survey. The blank survey can be found in Annexure A.

3.1.2 Finding the experts

The experts were found via personal contacts of the supervisors and the author and by especially searching for experts in the areas of waste management, sustainability, and behavioural science. In total 18 experts were contacted via E-mail from which eight responded and filled in the survey correctly. Two of them are professors at the UPC in the area of sustainability. Another two experts work as environmental consultants with specialisation in waste management. Also, two experts have been found that were in leading positions in different waste management organizations. One of them is now professor and leading expert for waste management topics at the University of Leoben. For the areas sociology and behavioural studies also two experts were found. Both are currently teaching at universities. All these experts provide expertise due to their numerous years of experience in their different areas. Furthermore, they provide a diverse insight into the topic due to their different areas of specialisation.

3.1.3 Processing of the answers

For processing the expert's data and gaining a final priority vector the data was put into an MS Excel file which is used as a template for similar calculations at the UPC. The steps which this Excel file executes to obtain the priority vectors and the consistency ratio of the pairwise comparison matrices are explained on the following pages. This process has been executed for both: "non-demographic drivers" and "demographic drivers".

3.1.3.1 Step 1 – bringing the answers into the right form

Two tables were built. One table for the non-demographic drivers and one table for the demographic drivers. The different drivers were alphabetically listed in the rows of the second column of the tables. The first column contains an identification-code for each of the factors. In the last row, the rating of the whole category is included. The data of the experts was then added in the columns. Each column represents the ranking of the expert mentioned above After all the data was inserted into the tables the highest given rank (lowest value), the lowest given rank (highest value), the variance and the mean value for each factor as well as for the rating of the categories have been calculated. The tables can be seen in the annexure.

3.1.3.2 Step 2 – Comparing the mean values of the drivers

The pairwise comparison is executed via matrices. One matrix for the non-demographic drives and one for the demographic drivers. In the first column and the first row of the matrices the different drivers are listed. Then their mean values out of the experts ranking were compared. This was done by subtracting the mean value of the driver mentioned in the first column from the mean value of driver mentioned in the first row (e.g.. ω_{ND2} –

ω_{ND1}). As the order of the drivers in the row is the same as of those in the column, the values of the diagonal of the matrices are 0.

3.1.3.3 Step 3 – Transforming the calculated differences into the pairwise comparison scale

In this step the calculated differences are brought into the scale of pairwise comparison, which can be seen in the table below:

Table 6: Used pairwise comparison scale to compare the drivers

Ratio	Relative importance between two criteria A and B
1	A and B are of equal importance
3	A is considered moderately more important than B
5	A is significantly more important than B
7	A is much more important than B
9	A is absolutely more important than B

The calculated differences were transformed into this scale by following formula the excel template for the pairwise comparison calculation:

Equation 10: Excel formula to transform the differences of the mean values of the rankings to the pairwise comparison scale

$$IF((driver_x - driver_y) < 0; MIN(9; ABS(driver_x - driver_y) + 1; 1/MIN(9; ABS(driver_x - driver_y) + 1)$$

This formula first checks if the difference between $driver_x$ and $driver_y$ is positive or negative. If the difference is negative it takes the absolute value of the difference, adds one and checks if the sum is lower than nine, which stands for the highest possible difference of importance. If yes, the sum is filled in, if no, the value nine is filled in. If the difference is positive the formula again adds one to the absolute value of the difference and then checks if the sum is below nine. If yes, the value one is divided by this sum, if no, the value one is divided by the value nine. This way a matrix is obtained where the diagonal has the values one, which stands for equal importance. This has to be this way because in the diagonal a value is always compared to itself. The values below and above the diagonal are reciprocal because of the following fact:

Table 7: Explanation of the reciprocity of the comparison of two drivers

Comparison of driver$_x$ with driver$_y$:	$a_{xy} = \frac{\omega_x}{\omega_y}$ *
Comparison of driver$_y$ with driver$_x$:	$a_{yx} = \frac{\omega_y}{\omega_x} = \frac{1}{\frac{\omega_y}{\omega_x}}$ **

*Relation between the weight of critera x (ω_x) and the weight of criteria y (ω_y)

**Relation between the weight of criteria y (ω_y) and the weight of criteria (ω_x)

3.1.3.4 Step 4 – Obtaining the priority vector

After all the comparison values are calculated, the sum for each column is made. To get the standardised values each comparison value is divided by the sum of the according column. Then for each row the mean value is calculated. The mean values of all the drivers (rows) represent the priority vector of the drivers. Each driver has now it's value of importance (weightage). The sum of all these values is 1.

3.1.3.5 Step 5- Checking for consistency

To check the matrix for consistency first of all the weight vector (w_s) is calculated by multiplying the not standardized pairwise comparison matrix (A) with the priority vector (w). This was done in excel by using the formula MMULT(). The obtained values are then divided by the priority vector to obtain the consistency vector (c). Out of the values of the consistency vector their mean value is calculated. This mean value represents the average consistency of the matrix and is also called eigenvalue (λ_{max}). Out of the eigenvalue and the amount of criteria the consistency index (CI) is calculated by following formula:

Equation 11: Calculation of the consistency index of a pairwise comparison matrix (Brunelli, 2015, p. 28)

$$CI(A) = \frac{\lambda_{max} - n}{n - 1}$$

The obtained consistency index is then divided by the Random Index (RI) which depends on the number of criteria to obtain the consistency ratio (CR). In this case a matrix of 12 criteria is given, therefore the RI is 1.54.

Equation 12: Calculation of the consistency ratio of a pairwise comparison matrix (Brunelli, 2015, p. 28)

$$CR(A) = \frac{CI\ (A)}{RI(n)}$$

3.1.3.6 Steps apart from the regular process

In this section occurring irregularities are explained and how they were handled.

3.1.3.6.1 Missing ranks or ratings

It occurred that some experts did not assign a rank to a given driver. In this case, their "ranking" for this driver was not included in the calculation of the mean value. Also some experts did not assign a rating to the categories "non-demographic drivers" and "demographic drivers". In this case their "rating" was also not included in the calculation for the mean rating.

3.1.3.6.2 Using the wrong scale for the ranking

One of the experts assigned the ranks of the demographic drivers by comparing them to the non-demographic drivers too. This expert assigned the ranks 5, 10 and 15 to the demographic drivers. These rankings were transformed into a ranking according to the right scale. The drivers which were seen as most important (rank 5) obtained the rank 1. For the other drivers the rank was calculated by adding the difference between the ranks that were assigned by the expert to the value 1. So the drivers which had received the rank 10 were assigned the rank 6, and the drivers which had been assigned the rank 15 now obtained the rank 11. This way this expert ranking could be compared to the rankings of the other experts.

3.1.3.6.3 Adding of new drivers

One of the experts added the driver "social implication" to the non-demographic drivers. As reason for adding this driver it was mentioned that *"if you are not socially implied in something, you don't see the reality".* Since this driver was only mentioned by one expert, it was not added to the study.

3.1.4 Results of the expert survey

In this section the results of the experts which participated in the survey are shown. The data is shown summarized for the two categories: "non-demographic drivers" and "demographic drivers". The filled in surveys and the excel tables can be found in the annexure.

3.1.4.1 Results for the non-demographic drivers

The table on the next page shows the results of the expert ranking of the non-demographic drivers. It shows the highest ranked position, the lowest ranked position and the mean value of all the drivers. Furthermore, it also shows the variances of the rankings for each driver. The rating of the importance of the category can be found in the last row.

Table 8: Results of the expert rankings of the non-demographic drivers

Non-demographic drivers					
Identification code	Driver	Highest rank	Lowest rank	Variance	Mean
ND1	Appearance and design of infrastructure	1	12	4.58	7.00
ND2	Awareness campaigns	3	12	2.86	7.75
ND3	Beliefs and values	1	11	3.64	4.63
ND4	Convenience of the collection system	1	9	2.69	3.50
ND5	Economic incentives	1	10	3.26	5.88
ND6	Environmental concern	2	8	2.17	4.75
ND7	Environmental education	3	9	1.79	5.25
ND8	Governmental regulations	1	11	3.00	5.63
ND9	Habits	2	10	3.33	5.71
ND10	Provided information	3	11	2.86	8.29
ND11	Social pressure	2	10	2.98	5.88
ND12	Trust in system	2	12	3.03	6.75
Rating of the category in %		**80.00**	**60.00**	**7.48**	**72.00**

These results were than processed according to the process explained in chapter 5.1.3. The obtained priority vector can be seen in table 9.

Table 9: Priority vector of the non-demographic drivers based on the expert rankings

Non-demographic drivers		
Identification code	**Driver**	**Weightage of the driver**
ND1	Appearance and design of infrastructure	0.04
ND2	Awareness campaigns	0.03
ND3	Beliefs and values	0.13
ND4	Convenience of the collection system	0.22
ND5	Economic incentives	0.07
ND6	Environmental concern	0.13
ND7	Environmental education	0.10
ND8	Governmental regulations	0.08
ND9	Habits	0.08
ND10	Provided Information	0.02
ND11	Social pressure	0.07
ND12	Trust in system	0.04

The consistency ratio of this pairwise comparison matrix is 0.009, which is clearly below 0.1. This means the matrix is consistent and the process does not have to be redone.

Looking at the highest and the lowest ranks of the drivers in table 8, it can be seen that the perceived importance of these drivers differs very strongly between the different experts. The biggest difference between highest rank (1) and lowest rank (12) can be

found for the driver “appearance and design of infrastructure”. Also, the drivers “beliefs and values”, “governmental regulations” and “trust in system” show very high differences (each of them 10 ranks) between the highest and the lowest rank. However, by looking at these variances, it can be found that, that they do not necessarily have the highest variances. The highest variances are shown by the drivers “appearance and design of infrastructure” (4.58), “beliefs and values” (3.64), “habits” (3.33) and “economic incentives” (3.26). The most homogenous ranking shows the driver “environmental education” with a variation of 1.79.

The importance of the drivers can be seen by looking at the mean values of the drivers, or more easily by looking at the relative importance (weightage) of the drivers in table 9. The experts considered “convenience of the collection system”, with a weight of 0.22, as the most important driver for waste separation behaviour. The second highest ranking is shared by the drivers “beliefs and values” and “environmental concern” with a weight of 0.13. Also environmental education (0.10), governmental regulations (0.08) and habits (0.08) are considered as important. As least important the driver “provided information” with a weight of 0.02 is seen. Also, the factors “awareness campaigns” (0.03), “appearance and design of infrastructure” (0.04) and “trust in system” (0.04) were not considered to be very important.

The whole category of the non-demographic drives is considered to influence the waste separation behaviour of a population by 72 %. The answers of the experts differ from this value in average by 7.48 %. The highest considered importance of this category is 80 %, while the lowest is 60 %.

3.1.4.2 Results for the demographic drivers

In this section the results for the demographic drivers are presented. In table 10 the results of the expert rankings of the demographic factors can be seen. It includes the highest given rank, the lowest given rank, the variance within the expert rankings and the mean rank of them. In the last column again the rating of the importance of the category in percent can be found.

Table 10: Results of the expert rankings of the demographic drivers

Demographic drivers					
Identification code	Driver	Highest rank	Lowest rank	Variance	Mean
D1	Age	1	12	4.26	6.86
D2	Employment status	1	9	2.29	4.86
D3	Family situation	1	8	2.32	4.43
D4	Gender	2	10	2.43	5.71
D5	Heritage and culture	1	11	3.20	4.43
D6	Income	1	9	2.47	4.86
D7	Level of education	1	11	3.09	4.14
D8	Location (urban, suburban, rural)	1	9	2.99	3.50
D9	Personal barriers	1	12	3.69	4.50
D10	Political preferences	1	10	2.96	5.29
D11	Social status	1	11	3.00	4.86
D12	Type of dwelling	1	11	3.52	5.86
Rating of the category in %		**40.00**	**20.00**	**7.48**	**28.00**

These results were then processed too according to the process described in chapter 5.1.3. to obtain the priority vector of the demographic drivers. As result the weightages of the drivers can be seen in table 11. These weightages represent the priority vector of the demographic drivers.

Table 11: Priority vector of the demographic drivers based on the expert rankings

Demographic drivers		
Identification code	**Driver**	**Weightage of the driver**
D1	Age	0.03
D2	Employment status	0.08
D3	Family situation	0.10
D4	Gender	0.05
D5	Heritage and culture	0.10
D6	Income	0.08
D7	Level of education	0.12
D8	Location (urban, suburban, rural)	0.17
D9	Personal barriers	0.10
D10	Political preferences	0.06
D11	Social status	0.08
D12	Type of dwelling	0.04

The consistency ratio of the pairwise comparison matrix of the expert rankings of the demographic drivers is 0.003. This value is below 0.1 which means the matrix is consistent and the process has been executed correctly.

By looking at the highest and lowest ranks which are shown in table 10 it can be seen that the ranks of demographic drivers also differ very strongly. The highest differences between the highest rank and the lowest rank can be found for the drivers “age” (1 and 12), personal barriers (1 and 12) “heritage and culture”, “level of education”, “social status” and type of dwelling (all 1 and 11). These drivers show also the highest variation of the expert rankings: 4.26 for “age”, 3.69 for “personal barriers”, 3.52 for “type of dwelling”, 3.20 for “heritage and culture”, 3.09 for “level of education” and 3.00 for “social status”.

The rankings were most homogenous for the drivers “employment status” (2.29), “family situation” (2.32) and “gender” (2.43).

The importance of the drivers can be seen in table 11 where the priority vector is represented. With a weightage of 0.17 the experts clearly consider the driver “location (urban, suburban, rural)” as the most important one. Second highest importance is seen in the driver “level of education” which obtains a weightage of 0.12. As equally important the drivers “family situation”, “heritage and culture” and “personal barriers” were considered, which all reached a weight of 0.10. As least important the experts considered the driver “age” which only reached a weight of 0.03. In their opinion also not very important are the drivers “type of dwelling” (0.04), “gender” (0.05) and “political preferences (0.06).

The influence of the category of the demographic drivers on waste separation behaviour was assigned an average importance of 28 % by the experts. The answers of the experts differ in average by 7.48 % from this value. The highest assigned rating is 40%, the lowest one is 20%.

3.2 Population surveys

The population survey allows insight into the perception of the populations of the cities of Barcelona and Leoben. The participants ranked the same factors as the experts by the same ranking process. This allows a comparison of the perceptions of the different groups.

3.2.1 Building of the survey

To obtain the rankings of the inhabitants of the cities of Barcelona and Leoben two online surveys were built via Google Forms: one for Barcelona and one for Leoben. This was done to have a clear separation of the results. These two surveys were built completely identical. The first two questions are in English asking the preferred language of the participant and if they are living in Barcelona or in Leoben. Depending on the answer on the language-question (possibilities were English, German, and Spanish) the next steps were presented in the according language.

First a short explanation of the survey was presented to the participants. Then they were asked to rank the non-demographic drivers and the demographic drivers separately on a scale from 1 to 12 (1 as most important, 12 as least important). This was done by a matrix where the participants could check the field of importance for each driver. The drivers were presented in alphabetical order, to not hand the participant any bias based on the rankings of the experts. In the last part, the participants were asked to rate the category of non-demographic factors and the category of demographic factors in percent based on their perceived importance of these categories for waste sorting behaviour. The answers

could be given as free text, as this was the only possibility to state percentages in Google Forms. No other data was collected from the participants.

3.2.2 Obtaining the results

The citizens from both the cities were contacted via personal connections, WhatsApp groups and in the case of Barcelona also various Facebook groups. Sending out the requests for participation, it was always mentioned that only inhabitants of the cities should take part. This was done to have a clear frame about who can participate and who cannot. However, because the surveys were spread via contacts and groups and because there was no further information requested from the participants, one cannot be completely sure about who really participated in the surveys.

3.2.3 Processing of answers

This section shortly explains how the answers were processed to obtain the priority vectors out of the ratings of the population surveys.

3.2.3.1 Calculating the total amounts for each rank of each driver

As already mentioned before, the surveys for the population of Leoben and the population of Barcelona were executed separately. Both surveys were divided into three sections: German, English and Spanish. The answers for each survey were received separately for each language section in form of a statistic for each driver. For each driver the results were presented in form of a histogram which showed how many times a rank has been assigned to the driver. These values were summed up for each rank of each driver over the different language sections.

3.2.3.2 Processing the data in Excel

Each survey (Barcelona and Leoben) was further processed in a separate Excel sheet. Two tables were built in each excel sheet: one for the non-demographic drivers and one for the demographic drivers. The rows of the table were assigned to the drivers (ND1 – ND12; D1 – D12) while the columns were assigned to the ranks (1-12). The total amounts for how often a rank has been assigned to a driver now could be filled in into these tables. For each of the driver the following values were then determined: the highest assigned rank, the lowest assigned rank, the total amount of how many times the driver has been ranked correctly in the survey, the mean rank and the variance.

3.2.3.2.1 Calculation of the mean rank

The mean value of each rank was calculated by following process: First the amount of how many times the rank has been assigned was multiplied with the rank itself. All the

values received by these process were then summed up and divided by the amount of times the driver was ranked correctly. The following equation shows this process:

Equation 13: Calculation of the mean rank of a driver (population survey)

$$m_i = \frac{\sum_{z=1}^{12} x_{iz} * z}{\sum_{z=1}^{12} x_{iz}}$$

3.2.3.2.2 Calculation of the variance

To calculate the variance for each driver following process was executed: The difference between each rank (1-12) and the mean rank of the driver has been calculated. Each of these values was then squared and multiplied by the ratio between the amount of how many times the rank has been assigned to the driver and the total amount the driver has been ranked. All of the received values were then summed up. Out of this sum then the square root was extracted. This process can be seen in the following equation:

Equation 14: Calculation of the variance of the assigned ranks from the mean rank of a driver (population survey)

$$v_i = \sqrt{\sum_{i=1}^{12} (z - m_i)^2 * \frac{x_{iz}}{\sum_{z=1}^{12} x_{iz}}}$$

3.2.3.2.3 Obtaining the priority vectors

The priority vectors are obtained by executing the same process that was already explained in 3.1.3 starting with “Step 2 – Comparing the mean values of the drivers”.

3.2.3.2.4 Steps apart from the usual process

It occurred that participants assigned two or more ranks to one driver. In these cases, for this driver the assigned ranks of this participant were not taken into account. This is the reason why numbers of valid rankings can differ between the ranked drivers.

3.2.4 Results of Leoben

In this part the results of the survey amongst the population of Leoben is presented. In total 45 participants filled in the survey.

3.2.4.1 Results for the non-demographic drivers

In table 12 the results for the non-demographic factors of this survey are presented. The table consist of the identification code, the name of the driver, the number of valid

rankings, the mean variance of the rankings from the calculated mean rank and the mean rank itself. As for all the drivers the ranks 1 and 12 have been assigned at least once, the columns “highest rank” and “lowest rank” are not included.

Table 12: Results for the non-demographic drivers for the population survey in Leoben

Non-demographic drivers				
Identifcation code	**Driver**	**Number of valid rankings**	**Variance**	**Mean rank**
ND1	Appearance and design of infrastructure	43	3.20	6.09
ND2	Awareness campaigns	45	3.12	6.16
ND3	Beliefs and values	44	3.48	4.55
ND4	Convenience of the collection system	45	3.70	4.73
ND5	Economic incentives	44	3.65	5.91
ND6	Environmental concern	44	3.43	4.73
ND7	Environmental education	43	3.40	6.07
ND8	Governmental regulations	43	3.47	5.21
ND9	Habits	44	3.60	3.98
ND10	Provided information	45	3.31	5.62
ND11	Social pressure	45	2.89	5.69
ND12	Trust in System	42	3.58	5.57

In table 13 the results for the rating of the category are shown.

Table 13: Rating of the category "non-demographic drivers" obtained by the population survey in Leoben

Rating of the non-demographic drivers	
Maximum rating	80.00 %
Minimum rating	30.00 %
Number of valid ratings	41
Variance	15.00 %
Mean rating	59.63 %

Out of the results of table 12 the priority vector for the non-demographic drivers were obtained. This priority vector can be seen in table 14 as weightages for the drivers.

Table 14: Priority vector for the non-demographic drivers based on the population survey in Leoben

Non-demographic drivers		
Identification code	**Driver**	**Weightage of the driver**
ND1	Appearance and design of infrastructure	0.05
ND2	Awareness campaigns	0.05
ND3	Beliefs and values	0.13
ND4	Convenience of the collection system	0.11
ND5	Economic incentives	0.05
ND6	Environmental concern	0.11
ND7	Environmental education	0.05
ND8	Governmental regulations	0.09
ND9	Habits	0.17
ND10	Provided information	0.06
ND11	Social pressure	0.06
ND12	Trust in system	0.07

The consistency ratio of the pairwise comparison matrix for this priority vector is 0.002. This value is clearly lower than the border value of 0.1. This means the matrix is consistent and the process does not have to be repeated.

By looking at table 12 it can be seen that the variances of all the drivers are in a similar range. The lowest variance can be found for the driver “social pressure” with 2.89 ranks. The driver variance has the drive “Convenience of the collection system” with 3.70 ranks.

Further drivers with high variance values are “Economic incentives” (3.65), “Habits” (3.60) and “Trust in System” (3.58).

The drivers which were considered most important by the participants are “Habits” with a weightage of 0.17, “Beliefs and Values” with a weightage of 0.13, “Environmental concern” and “Convenience of the collection system” which both obtained a weightage of 0.11. The drivers that were considered less important in this survey are “Trust in System” with a weightage of 0.07, “Provided information” and “Social pressure” both with a weightage of 0.06 and “Appearance and design of infrastructure”, “Awareness campaigns”, “Economic incentives” and “Environmental education” all with a weightage of 0.05.

Overall, the participants of Leoben consider the non-demographic drivers to influence waste separation behaviour by 59.63 %. However, this differs strongly between the participants. The highest assigned rating to this category is 80 % while the lowest one is 30 %. The overall variance of the ratings is 15.00 %.

3.2.4.2 Results for the demographic drivers

In table 15 the results of the ranking of the demographic drivers can be seen. The table again consists out of the identification code, the drivers name, the number of correct rankings, the variance of the rankings and the mean rank. The highest rank and lowest rank of each driver are not presented because except for the driver “Age” the ranks 1 and 12 have been assigned at least once to all the drivers. For the driver “Age” the rank 12 has not been assigned.

Table 15: Results for the demographic drivers for the population survey in Leoben

Demographic drivers				
Identifcation code	**Driver**	**Number of valid rankings**	**Variance**	**Mean rank**
D1	Age	44	2.77	5.61
D2	Employment status	44	2.99	5.86
D3	Family situation	45	3.39	5.71
D4	Gender	44	4.29	7.18
D5	Heritage and culture	44	3.59	5.61
D6	Income	43	3.10	6.88
D7	Level of education	44	3.28	4.32
D8	Location (urban, suburban, rural)	44	3.27	4.77
D9	Personal barriers	45	3.11	6.24
D10	Political preferences	44	3.18	6.48
D11	Social status	45	3.34	5.76
D12	Type of dwelling	45	3.51	5.09

In table 16 the results for the rating of the category “demographic drivers” can be seen:

Table 16: Rating of the category "demographic drivers" obtained by the population survey in Leoben

Rating of the demographic drivers	
Maximum rating	70.00 %
Minimum rating	20.00 %
Number of valid ratings	41
Variance	15.00 %
Mean rating	40.37 %

Out of the results of table 15 the priority vector for the demographic drivers was obtained. Table 17 presents this priority vector in form of weightages for each driver.

Table 17: Priority vector for the demographic drivers based on the population survey in Leoben

Demographic drivers		
Identification code	**Driver**	**Weight of the driver**
D1	Age	0.08
D2	Employment status	0.07
D3	Family situation	0.08
D4	Gender	0.03
D5	Heritage and culture	0.08
D6	Income	0.04
D7	Level of education	0.17
D8	Location (urban, suburban, rural)	0.14
D9	Personal barriers	0.06
D10	Political preferences	0.05
D11	Social status	0.08
D12	Type of dwelling	0.12

The pairwise comparison matrix for the demographic drivers reached a consistency ratio of 0.003. This value is clearly below 0.1, which means that the matrix is consistent, and the process has been executed correctly.

The rankings of the demographic drivers differ in a slightly wider range from the mean values than the rankings of the non-demographic drivers. The highest variance shows the driver “Gender” with a variance of 4.29 ranks. Second highest variance shows the driver “Heritage and culture” with 3.59 ranks. The two drivers with the lowest variances are “Age” with 2.77 ranks and “Employment status” with 2.99. The other drivers show a variance in the rage between 3.10 and 3.51.

The perceived importance of the drivers can be seen by looking at the weightages in table 17. Clearly most important are the drivers “Level of education” with a weightage of 0.17 and “Location (urban, suburban, rural) with a weightage of 0.14. The participants perceived the drivers “Age”, “Family situation”, “Heritage and culture” and “Social status” as equally and moderately important (all obtained a weightage of 0.08). Considered as not very important were the drivers “Income” (0.04), “Political preferences” (0.05), “Personal barriers” (0.06) and “Employment status” (0.07).

Overall, the participants assigned an importance of 40.37 % to the demographic drivers. However, here also the perceptions differ. Lowest assigned importance was 20 % while the highest one was 70%.

3.2.5 Results for Barcelona

In this chapter the results of the survey amongst the population of Barcelona is presented. In total 44 habitants of the city of Barcelona participated in the survey.

3.2.5.1.1 Results for the demographic drivers

In table 18 the results for the rankings for the non-demographic drivers of the participants from Barcelona can be seen. The table consists of the identification code of the drivers, the names of the drivers, the number of valid rankings, the overall variance for each driver and the mean rank assigned to each driver. The highest rank and the lowest rank are not presented because every driver received the ranks 1 and 12 at least one time.

Table 18: Results for the non-demographic drivers for the population survey in Barcelona

Non-demographic drivers				
Identifcation code	**Driver**	**Number of valid rankings**	**Variance**	**Mean rank**
ND1	Appearance and design of infrastructure	43	3.71	5.30
ND2	Awareness campaigns	43	3.78	5.26
ND3	Beliefs and values	43	3.53	3.37
ND4	Convenience of the collection system	44	3.90	3.95
ND5	Economic incentives	43	3.64	5.02
ND6	Environmental concern	43	3.35	3.56
ND7	Environmental education	44	3.46	4.09
ND8	Governmental regulations	44	3.40	4.43
ND9	Habits	43	3.37	3.67
ND10	Provided information	43	3.48	5.02
ND11	Social pressure	42	3.78	5.48
ND12	Trust in System	43	4.04	4.40

The rating of the category “non-demographic drivers” can be seen in table 19.

Table 19: Rating of the category "non-demographic drivers" obtained by the population survey in Barcelona

Rating of the non-demographic drivers	
Maximum rating	80 %
Minimum rating	10 %
Number of valid ratings	41
Variance	16.22 %
Mean rating	56.83 %

Out of the ranks in table 18 the priority vector for the non-demographic values was obtained. It is presented as weightages of the drivers in table 20 on the next page.

Table 20: Priority vector for the non-demographic drivers based on the population survey in Leoben

Non-demographic drivers		
Identification code	**Driver**	**Weight of the driver**
ND1	Appearance and design of infrastructure	0.04
ND2	Awareness campaigns	0.05
ND3	Beliefs and values	0.15
ND4	Convenience of the collection system	0.10
ND5	Economic incentives	0.05
ND6	Environmental concern	0.13
ND7	Environmental education	0.10
ND8	Governmental regulations	0.08
ND9	Habits	0.12
ND10	Provided Information	0.05
ND11	Social pressure	0.04
ND12	Trust in system	0.08

The used comparison matrix achieved a consistency ratio of 0.002 which is clearly below the border value of 0.1. Therefore, the matrix is consistent, and the process has been executed correctly.

The variances of the different driver are all in a close range. The highest variance can be found for the driver “Trust in system” for which the average variance is 4.04. The driver with the lowest variance is “Environmental concern” with a value of 3.35. All the other variances can be found between these two values.

By looking at the weightages in table 20 it can be seen that the drivers which are considered most important are “Beliefs and values” with a weightage of 0.15 and “Habits” with a weightage of 0.12. The drivers “Convenience of collection system” and “Environmental education” achieved a weightage of 0.10 and therefore, are also considered to be important. The drivers “Appearance and design of infrastructure” and “Social pressure” are seen as least important. They both obtained a weightage of 0.04. Furthermore, with a weightage of 0.05 the drivers “Economic incentives” and “Provided information” are also of low importance to the participants.

Overall the participants assign an importance of 56.83 % to the category of “non-demographic drivers”. However, the assigned ratings differ widely. The highest assigned rating is 80 %, while the lowest assigned rating is 10 %. Overall, the variance of the rating is 16.22 %.

3.2.5.2 Results for the demographic drivers

This section shows the results for the demographic drivers of the population survey in Barcelona. In table 21 the identification codes, the names of the drivers, the amounts of valid rankings, the average variance for each drive and the mean assigned rank of each driver are presented. Again, highest and lowest rank are not shown, as every driver received the ranks 1 and 12 at least one time.

Table 21: Results for the demographic drivers for the population survey in Barcelona

Demographic drivers				
Identifcation code	**Driver**	**Amount of valid rankings**	**Variance**	**Mean rank**
D1	Age	43	3.32	6.53
D2	Employment status	43	3.99	6.33
D3	Family situation	43	3.68	6.23
D4	Gender	43	4.32	7.60
D5	Heritage and culture	44	3.52	4.95
D6	Income	43	3.84	6.51
D7	Level of education	43	3.93	4.70
D8	Location (urban, suburban, rural)	44	3.87	5.55
D9	Personal barriers	42	3.84	5.12
D10	Political preferences	43	3.72	6.60
D11	Social status	43	3.57	6.67
D12	Type of dwelling	43	4.06	6.12

Table 22 shows the rating of the category “demographic drivers” based on its influence on waste separation behaviour.

Table 22: Rating of the category "demographic drivers" obtained by the population survey in Barcelona

Rating of the demographic drivers	
Maximum rating	90 %
Minimum rating	20 %
Number of valid ratings	41
Variance	16.22 %
Mean rating	43.17 %

The mean rankings of table 21 were then processed in Excel to obtain the priority vector of the demographic drivers. It can be seen in table 23 in form of weightages for each driver.

Table 23: Priority vector for the demographic drivers based on the population survey in Leoben

Demographic drivers		
Identification code	**Driver**	**Weight of the driver**
D1	Age	0.06
D2	Employment status	0.06
D3	Family situation	0.07
D4	Gender	0.03
D5	Heritage and culture	0.14
D6	Income	0.06
D7	Level of education	0.17
D8	Location (urban, suburban, rural)	0.10
D9	Personal barriers	0.13
D10	Political preferences	0.05
D11	Social status	0.05
D12	Type of dwelling	0.07

The used pairwise comparison matrix to obtain these drivers achieved a consistency ratio of 0.003. This value is also below 0.1, which means the matrix is consistent and the process has been executed correctly.

In table 21 the variances of the rankings for the drivers can be seen. The highest variance shows the driver “Gender” with 4.32 ranks, followed by “Type of dwelling” with 4.06 ranks. The clearly lowest variance can be found for the driver “Age” 3.32 ranks.

The weightages show the perceived importance of the drivers to the participants. With a weightage of 0.17 the driver “Level of education” is seen clearly as the most important

driver. Also very important drivers are “Heritage and culture” with a weightage of 0.14 and “Personal barriers” with a weightage of 0.13. “Gender” was considered the least important driver and achieved a weightage of 0.03. But also “Political preferences” and “Social status” which each obtain a weightage of 0.05 and “Age”, “Employment status” and “Income” with a weightage of 0.06 are not considered to be very important.

Overall, the category of “demographic drivers” was assigned an importance of 43.17 % for waste separation behaviour. However, the ratings differ in a wide range. The highest given rating is 90 % while the lowest given rating is 20 %. The average variance between the ratings and the mean rating is 16.22 %.

4 Interpretation, comparison, and discussion

In this section the results for the different questioned groups are discussed, compared with each other and the differences are then interpreted.

4.1 Discussion of the expert survey

As it can be seen in Table 1, the participating experts provide an insight into the topic from various different angles, as they specialized in different fields of sustainability, waste management and even psychology. They all have years of experience in their fields. Therefore, the results of their rankings are seen as valid and very valuable. However, like in section 3.1.3.6 already explained, some of them had troubles filling in the survey completely correct. It seems like either the explanation or the build-up of the survey have not been clear enough to them. This affects especially the rating of the categories, as they only have been filled in by five of the eight experts. It has to be said, that the result for the category rating (72% non-demographic, 28 % demographic) might be different, if all the experts would have participated in this rating.

Also, some of the experts did not assign a rank to some of the drivers because they did not perceive them as important. However, as this never happened more than twice for a driver, all the drivers found in literature are still included in the study. These “blank ratings” were not included with a value in the calculation of the mean ranks. This certainly affects the results of the mean rankings, but the method was seen as the most conflict-free one, as no values had to be estimated.

As already mentioned, one of the experts added the driver “Social implication”. However, as this driver only was mentioned by one expert, it was not included in the study.

4.2 Discussion of the population survey of Leoben

As the results of the population survey have been received via personal contacts (and their contacts) there might be a certain bias in these results. As most of the personal contacts and also their contacts are students at the University of Leoben the conclusion is, that most of the participants of the survey are also students. This means, the questioned group is not really representative for the population of Leoben. It was also tried to spread the survey amongst the rest of population of Leoben, but it can be assumed that the rate of participation for this group is way smaller, as there exist little to no personal connections. However, as no personal data of the participants was collected, it cannot be said who really participated in this study. It only can be assumed because of the said reasons, that there might be a bias to the answers. This should be taken into consideration when looking at the results of the survey.

4.3 Discussion of the population survey of Barcelona

The population survey of Barcelona was more diverse than the survey for Leoben. This means, it most likely also reached a more diverse group of people. However, it still should be assumed, that students are overrepresented in this survey, as still the personal contact of the author to students is more developed than to the rest of the population. What also needs to be mentioned is, that 29.5 % of the respondents preferred the German language and 25 % chose English to complete the survey. This is the result of sharing the survey in Facebook groups for international people who now live in Barcelona and also other international people who live there now. However, the main share of the participants (45.5 %) still chose Spanish as their preferred language. In summary it can be said that the group which participated in the populations survey is much more diverse for Barcelona than for Leoben. However, it still cannot be said, that the survey group is representative for the population of Barcelona. This has to be considered when looking at the results of the survey.

4.4 Interpretation and comparison between Experts, Leoben and Barcelona

In this section the results of the survey amongst the population of Leoben and amongst the population of Barcelona are compared to each other and to the results of the expert group. This comparison is based on the calculated weightages for the drivers and the assigned importance for the categories of “non-demographic drivers” and “demographic drivers”.

4.4.1 Interpretation and comparison of the results for the non-demographic drivers

In the following table the assigned weightages of the experts, the participants of Leoben and the participants of Barcelona for the non-demographic drivers are shown. In the paragraphs after the table the results for each driver are discussed separately.

Table 24: Comparison of the priority vectors for the non-demographic drivers assigned by the experts group and the population groups of Leoben and Barcelona

Comparison of the priority vectors of the non-demographic drivers			
Driver	**Weightage Experts**	**Weightage Leoben**	**Weightage Barcelona**
Appearance and design of infrastructure	0.04	0.05	0.04
Awareness campaigns	0.03	0.05	0.05
Beliefs and values	0.13	0.13	0.15
Convenience of the collection system	0.22	0.11	0.10
Economic incentives	0.07	0.05	0.05
Environmental concern	0.13	0.11	0.13
Environmental education	0.10	0.05	0.10
Governmental regulations	0.08	0.09	0.08
Habits	0.08	0.17	0.12
Provided information	0.02	0.06	0.05
Social pressure	0.07	0.06	0.04
Trust in system	0.04	0.07	0.08
Importance of the category	72.00 %	59.63 %	56.83 %

4.4.1.1 Appearance and design of infrastructure

This driver is for all the groups of very low importance. This means that the tidiness, the optical appearance and user-friendly design of the infrastructure is considered to not have a big impact on waste separation behaviour of a population. Remarkable is the high similarity between the assigned weightages (0.04, 0.05, 0.04). These results are very

contrary to what was found in the literature research. There “Appearance and design of infrastructure” is considered to be a very important external driver. The diversity and experience of the expert group and the consistency of the results of the questioned groups allows the assumption that too much importance is put onto this factor by waste management companies. However, before lowering efforts for designing and maintaining the infrastructure, further studies in which collection rates of different areas (with different level of tidiness, different containers and different arrangement) would be needed.

4.4.1.2 Awareness campaigns

Awareness campaigns are also considered to not have a big influence on waste separation behaviour by all of the groups. For the experts, they are even less important than “Appearance and design of infrastructure”, obtaining a weightage of only 0.03. Both of the population groups only assigned a slightly higher weightage (0.05) to this driver. In the literature awareness campaigns are furthermore mostly mentioned in relation to motivate certain groups of the population and is not often discussed in general. All this shows that awareness campaigns do not play a big role in influencing the participation in waste separation of a population. This finding may be based on the fact, that the general importance of waste separation has already been realized by most of the surveyed population. The need to emphasize this importance is not given any more.

4.4.1.3 Beliefs and values

“Beliefs and values” are one of the most important drivers to all the participating groups. For the participants in Barcelona, it is even the most important driver (weightage of 0.15), while it is the second most important driver for the participants of Leoben and the experts group (both weightages of 0.13). This means, all the participants think that intrinsic motivation that comes from beliefs and values is essential for good waste separation behaviour of people. A lack of this motivation can barely be compensated by external factors. This conclusion can also partly be confirmed by the found literature (Miafodzyeva et al., 2013, Hage and Söderholm, 2008, Matthies, 1994, Schwartz, 1977, Lingqiong et al., 2022) which basically says that beliefs, values, attitude towards a behaviour and felt responsibility affect a person’s waste separation behaviour strongly. However, in literature it is also mentioned that if the surrounding conditions are unsatisfying, these internal drivers lose their positive influence. This statement is also supported by the results of the expert group, which rated the driver “Convenience of the collection system” as most important driver for waste separation behaviour. In conclusion it can be said that it is highly important to establish the feeling of personal responsibility within a population.

4.4.1.4 Convenience of collection system

This is the driver with the biggest discrepancy between the perceived importance of the experts group and the two population groups. For the experts group it is by far the most important driver (weightage of 0.22) for waste separation behaviour, while the groups of the population survey of both cities only assign moderate importance to it in comparison to the experts group (weightages of 0.11 and 0.10). This could indicate that waste management companies and official organisations put way too much effort in their collection systems to make the participation as easy as possible. However, in the examined literature it was found that the lack of convenience affects the participation in waste separation strongly. Furthermore, it was stated in the study of Stoeva and Alriksson (2017) that "satisfaction with the local facilities" loses its predictive aspect if people are satisfied with the provided systems. This finding can be confirmed by the obtained results of the surveys. Since in both cities the infrastructure for waste collection is highly developed, people do not recognize the convenience of the provided infrastructure anymore. However, this makes convenient infrastructure not less important, as the lack of convenience would be recognized.

4.4.1.5 Economic incentives

All the groups assigned relatively low importance to the driver of economic incentives (0.07 for the experts and 0.05 for Leoben and Barcelona). This shows that neither experts nor citizens believe that a population can be motivated to participate in waste separation by incentives like lower costs, vouchers or money. It seems that generally wealthy communities like Barcelona (average salary in 2020: 30.593 € per year (Ajuntament de Barcelona, 2020)) and Leoben (average salary in 2020: 35.686 per year (Das Land Steiermark, 2020)), the average population does not care too much about relatively low economic incentives. Preserving the convenience level of the daily life seems to be more important. The positive side is, that it seems that experts already are aware of this attitude, what can prevent waste management companies from implementing expensive systems which focus on this kind of extrinsic motivation. However the literature (Becker, 2014, Shen et al., 2019), indicates that it could be useful to provide economic incentives for groups with lower income (e.g. students), as these incentives have more value for them.

4.4.1.6 Environmental concern

"Environmental concern" is seen as one of the more important drivers by all the questioned groups. For the group of Leoben it is the third most important driver (weightage of 0.11) and for the group of Barcelona and the experts group it is the second most important driver (weightage of 0.13 for both). These results also fit very well to the results of the driver "Beliefs and values" as these two are both intrinsic drivers. The feeling

of responsibility for the wellbeing of animals and for protecting the nature is closely related to the believes and values of a person. According to the results of the experts group and because of the professional careers of some of them (working for waste management companies / as environmental consultants), it could be inferred that the waste management companies know about the importance of this intrinsic drivers. It is the obligation of these companies and of governmental organisations to activate these altruistic feelings towards the environment and connect them to waste separation.

4.4.1.7 Environmental education

The driver shows the first bigger discrepancy between the results of the two population surveys. While the participants of Barcelona consider “Environmental education” as moderately important (weightage of 0.10) the participants consider it as not very important (weightage of 0.05). The group of experts tend to support the view of the participants from Barcelona (weightage of 0.10). This can maybe be explained by the composition of the group from Leoben. It cannot be said clearly who participated in the population survey, but for Leoben it can be assumed that most of the participants are students at the University of Leoben. Since it is a university of sciences and engineering, these students have at least basic knowledge about environmental topics. In their surrounding the knowledge about environmental topics is not an issue anymore and therefore, this driver is not recognized as being important. It can be assumed that the group of Barcelona is more diverse and therefore, still recognizes the importance of this driver. Because of the rankings of the experts and the group of Barcelona and the statements in the found literature, it can be concluded that “Environmental education” is a driver when it comes to waste separation. Furthermore, education about environmental issues can help to develop environmental concern and the feeling of responsibility for the environment.

4.4.1.8 Governmental regulations

Governmental regulations are seen as only moderately important by all the questioned groups. The experts group and the group of Barcelona assigned a weightage of 0.08 and the group of Leoben of 0.09. This shows that external force and pressure is perceived as even less effective then external incentives. This can partly be explained by the reason that for waste separation regulations and laws are hard to execute and control. Therefore, even if there exist regulations and laws, the population is not very motivated to follow them. Another part of the explanation could be that external forces in general are just not suited well to influence waste separation behaviour.

4.4.1.9 Habits

The driver “Habits” is seen very differently by all the participating groups. For the group of Leoben it is the most important driver (weightage of 0.17) and for the group of Barcelona it is the third most important driver (weightage of 0.13), while the group of experts perceives its importance only to be moderate (0.08). These results indicate that experts might think that habits in waste separation are easily changeable, while the population groups see habits and learned behaviour as bigger hurdle for people to participate in waste separation. This also means, that the population groups believe that people might not take part in waste separation because of their learned behaviour, even if the external circumstances and the right attitude are given. It might be the case, that experts underestimate the effect of habits. These findings show the importance of practical education in waste related issues (particularly waste separation) especially during the early years of life, as habits are formed and can be influenced easier while growing up. Already developed habits need a lot more effort to be transformed again.

4.4.1.10 Provided information

The availability of information about how and where to separate waste correctly is seen as very less important by all the questioned groups. However, the groups of Leoben (weightage of 0.06) and of and Barcelona (weightage of 0.05) perceive this information as significantly more important than the expert’s group (weightage of 0.02). In fact, the experts rated the driver “Provided information” as the least important non-demographic driver. So although, the population groups think that this driver does not affect waste separation behaviour very much, they still assign more importance to it than the experts do.

4.4.1.11 Social pressure

Social pressure is not perceived to have a big influence on a person’s waste separation behaviour by all the questioned groups. The experts assigned a weightage of 0.07, the participants of Leoben of 0.06 and the participants of Barcelona of 0.04. This result indicates again that extrinsic forces do not seem to have a big influence on waste separation behaviour. However, in literature (Ajzen and Fishbein, 1975, Dongliang et al., 2015, Brenncke, 2004) social pressure was closely related to the subjective norm of a person which again influences intention and in the end even behaviour. It may be, that the asked groups are not aware of these connections because they take place in the subconscious part of the mind. This is a point that needs further examination and maybe even action by authorities and waste management companies.

4.4.1.12 Trust in system

The experts assigned only low importance to this driver (weightage of 0.04), while the population groups assigned moderate importance (weightages of 0.07 for Leoben and 0.08 for Barcelona). These results indicate that knowledge about how the collected waste is processed and how the materials are used after the recycling process does not have a big influence on waste separation behaviour. However, this knowledge is still clearly more important to the population groups than to the group of experts. Furthermore, it was shown in literature (Rückert-John et al., 2021, Kossakowski, 1999, Brenncke, 2004) that the lack of trust in the recycling process and the waste management system is one of the most mentioned barriers for not participating in waste separation. According to these results, further examination of this driver would be suggested.

4.4.2 Interpretation and comparison of the results for the demographic drivers

In table 25 the priority vectors assigned by the different groups can be seen as weightages for each driver. The weightages for each driver are discussed in the sections below the table.

Table 25: Comparison of the priority vectors for the demographic drivers assigned by the experts group and the population groups of Leoben and Barcelona

Comparison of the priority vectors of the demographic drivers			
Driver	**Weightage Experts**	**Weightage Leoben**	**Weightage Barcelona**
Age	0.03	0.08	0.06
Employment status	0.08	0.07	0.06
Family situation	0.10	0.08	0.07
Gender	0.05	0.03	0.03
Heritage and culture	0.10	0.08	0.14
Income	0.08	0.04	0.06
Level of education	0.12	0.17	0.17
Location	0.17	0.14	0.10
Personal barriers	0.10	0.06	0.13
Political preferences	0.06	0.05	0.05
Social status	0.08	0.08	0.05
Type of dwelling	0.04	0.12	0.07
Importance of the category	28.00 %	40.37 %	43.17 %

4.4.2.1 Age

The driver is considered to be the least important demographic driver by the experts group (weightage of 0.03). Also, the population group of Barcelona thinks that age has not a big influence on waste separation behaviour (weightage of 0.06), while the group of Leoben assigns a moderate importance to it (weightage of 0.08). However, it was shown in various studies (Rückert-John et al., 2021, Lin et al., 2017, Meneses and Palacio, 2005) that age has an influence on waste separation behaviour. It was mentioned that younger and elderly people participate less in waste separation. While the group of elderly people face more barriers to transfer good intentions into actual actions, younger people often state to not know how to recycle correctly, that recycling is to elaborate or that they have no trust in the system. The reason why the groups assigned such low importance to this driver could be that the awareness for the relation of age to the before mentioned statements is not recognized. It is assumed that most of the respondents are between the age of 25 and 60 and therefore, cannot really relate to the barriers of the elderly and the statements of the young group.

4.4.2.2 Employment status

The groups assigned moderate to low importance. Weightages of 0.08 from the experts, 0.07 from the group of Leoben and 0.06 from the group of Barcelona indicate, that neither the lack of time of employed residents nor the lack of motivation of unemployed residents have a big influence on waste separation behaviour. Therefore, it can be concluded that it also does not make much sense to try to address unemployed residents separately to motivate them towards a positive waste separation behaviour.

4.4.2.3 Family situation

While the experts see “Family situation” as a rather important driver (weightage of 0.10), the groups of Leoben (weightage of 0.08) and Barcelona (weightage of 0.07) assigned only moderate importance to it. It can be said that all groups perceive that living with a partner and/or with children has an effect on waste separation behaviour. However, the relatively low weightages indicate, that this driver is not perceived to be as important as it was said in the found literature (Becker, 2014, Klineberg et al., 1998, Dongliang et al., 2015). In this context it has to be said that it is assumed most participants of the population surveys are students and do not have children yet. This point is considered to be interesting for further studies.

4.4.2.4 Gender

Gender obtained low weightages by all the questioned groups (0.05 from the experts and 0.03 from both population groups). This results are contradictory to findings of the literature research, where it was found by Becker (2014) that men have weaker pro-environmental attitudes and by Rückert-John et al. (2021) that women separate waste more consequently. So, the findings of the surveys and the those of the literature research show a clear gap. Especially interesting is, that the experts did not assign a higher importance to this driver, as they have access to knowledge and data about waste separation behaviour. The population groups on the other hand, might not clearly be aware of certain influences like gender.

4.4.2.5 Heritage and culture

Heritage and culture are seen as the second most important driver by the group of Barcelona (weightage of 0.14) while the experts and the group of Leoben only assigned moderate importance to it (weightages of 0.10 by experts and 0.08 by the group of Leoben). Here clearly the differences of internationality between the two examined cities can be seen. While the city of Barcelona has a share of foreigners of 17 % (World Population Review, 2022), the population of Leoben consists only to about 11.5 % (Statistik Austria, 2022) of foreigners. Therefore, the citizens of Barcelona get in contact with people from different countries and cultural backgrounds more often than the inhabitants of Leoben. It seems that this closer contact has a strong influence on the perception of the population group of Barcelona regarding this driver. It might have made them more aware of behavioural differences that are caused by heritage and culture.

4.4.2.6 Income

The driver “Income” is not seen as very important by all the groups. The experts assigned the highest importance of all the asked groups with a weightage of 0.08, while the group of Barcelona assigned a weightage of 0.06. For the participants of Leoben it is even the least important driver with a weightage of 0.04. The found literature provides a contradictory perception. Most of the studies examined by Miafodzyeva et al. (2013) found a relation between income and recycling behaviour. Owens et al. (Owens et al., 2002) report a higher participation level in areas with middle to upper level of income and according to Kurz et al. (2007) low income areas show the lowest participation in recycling. The assumption can be made, that “Income” is a driver which is generally underestimated.

4.4.2.7 Level of education

Level of education is the most important driver for both population groups (weightage 0.17) and the second most important driver for the experts (weightage 0.12). The assumption can be made, that the level of education is perceived to be somehow related to knowledge about environmental topics and perceived importance of waste separation. However, literature does not show consistent results for the influence of education on waste separation behaviour. Lin et al. (2017) stated that a degree does not automatically is a guarantee for environmental knowledge. Anyways, it is seen as important that children are taught about environmental issues and waste separation in the early stages of education. This way, not only the possibly existing effect of the educational level can be eliminated, but it could also create generations with high environmental awareness and slowly transform the society.

4.4.2.8 Location (urban, suburban, rural)

For the experts group “Location” is the most important demographic driver with an assigned weightage of 0.17. The population groups feel that this driver is a little less important. The participants of Leoben assigned a weightage of 0.14 (second most important driver) and the participants of Barcelona assigned a weightage of only 0.10. That the experts see this driver as the most important demographic one is understandable, as it defines the collection system. That the participants of Leoben also perceive it as an important driver can be possibly explained by two facts: Number one is, that Leoben is a relatively small city where people have good connections to the surrounding villages. Therefore, they can see differences in the waste collection infrastructure. The second reason might be, that many of the participants moved to Leoben for studies and therefore, know different collection schemes.

4.4.2.9 Personal barriers

The participants of Leoben assign low importance to the driver “Personal barriers” (weightage of 0.06), while the experts assign moderate (weightage of 0.10) and the participants of Barcelona attribute high importance (weightage of 0.13) to this driver. The low perceived importance of the group of Leoben can possibly be explained by the provided infrastructure. In Leoben bigger housing complexes most likely have their own collecting points, many buildings are equipped with an elevator and there exist helping services for elderly people. In Barcelona there are mostly public collection points and many buildings do not have elevators. If there exist helping services for elderly people is not known. In summary it can be said that this point is very closely related to the driver “Convenience of the collection system”. If help to overcome personal barriers is provided and participation even for handicapped persons is made as easy as possible, personal

barriers might not be seen as an important issue. However, if this infrastructure is not given, personal barriers have a big influence on waste separation behaviour.

4.4.2.10 Political preferences

Political preferences are perceived not to have a big influence on waste separation behaviour. The experts group assigned a weightage of 0.06 and both population groups a weightage of 0.05. Thus, it could be safely assumed, that awareness of environmental issues and importance of waste separation have reached people of all political preferences. Of course, there are and will always be more extreme groups which don not want to acknowledge reality, but they usually are not part of the most common political preferences of a population.

4.4.2.11 Social status

The driver “Social status” was assigned moderate importance (weightage of 0.08) by the experts group and the participants of Leoben. The participants of Barcelona assigned an even lower importance to it (weightage of 0.05). The difference between the participants of the two cities might be explainable by their size and the concluding social connections in the surrounding. In Leoben people still know each other and people with a certain social status still can be role models to others. Their opinion is often highly appreciated within a society. This effect might get lost with the anonymity of bigger cities. Therefore, the effect of the driver “Social status” might also be connected to the location.

4.4.2.12 Type of dwelling

The driver “Type of dwelling” shows very heterogeneous results. While the experts group (weightage of 0.04) and the participants from Barcelona (weightage of 0.07) assigned low importance to it, for the participants of Leoben it is the third most important demographic driver (weightage of 0.12). As the participants of Leoben are mostly students which have lived in other parts of the country before and most likely have changed their type of dwelling by moving to Leoben (out of their parent’s household), they have experienced different collection systems and their effect on waste separation behaviour. As in the year 2011 (latest report) 68.87 % of the 101.850 buildings in Barcelona that are dedicated for housing contained 3 or more flats, it can be concluded that most of Barcelona’s population live in multi-occupancy houses (Instituto de Estadística de Cataluña, 2011). Therefore, it can also be assumed that most of the participants of this study live in this type of dwelling. It can be assumed that some of them never got into contact with another collection system than the in Barcelona common central collection points. Therefore, maybe they are just not aware that a different type of dwelling often comes with a different type of collection system and that this can have an effect on waste separation behaviour. That the experts assigned such a low importance can possibly indicate their perception that the

convenience and tidiness of all the collection systems for every type of dwelling is good enough and therefore, type of dwelling should have no effect on waste separation behaviour.

4.4.3 Rating of the categories

In this section the ratings of the two categories of drivers is discussed. Table 26 shows the ratings for the “category of non-demographic drivers” and the “category of demographic drivers” of all the questioned groups. In the paragraph below the table the results are shortly discussed.

Table 26: Ratings of the "category of non-demographic drivers" and the category of "demographic drivers" by the experts group and the population groups of Leoben and Barcelona

Rating of the categories			
Category	**Rating Experts**	**Rating Leoben**	**Rating Barcelona**
Non-demographic drivers	72.00 %	59.63 %	56.83 %
Demographic driver	28.00 %	40.37 %	43.17 %

All the asked groups have the perception that the non-demographic drivers are more important than the demographic drivers. However, with percentages of 59.63 % for the group of Leoben and 56.83 % for the group of Barcelona, assigned significantly lower importance to the non-demographic drivers than the group of experts, which assigned 72.00 % to it. With ratings close to the ratio 60/40 the population groups have the feeling that the influence of these two categories is way more equally distributed than the experts do. This difference might be caused by the experience, the knowledge and the available data the experts have, while the rating of the population groups is based on feeling. However, at this point it has to be mentioned, that only five of the eight experts provided a valid rating of the categories.

5 Conclusions

To achieve a system that is closer to a circular economy, the collection of waste has to be improved, as to recycling something, it first needs to be collected. While the waste recycling infrastructure already is very highly developed in many countries of the European Union, the participation of the population (eg. their waste sorting behaviour) still shows a lot of potential for improvement. This study examined the major drivers that influence the waste separation behaviour of a population.

The different identified drivers were ranked by applying the pairwise comparison method of the AHP on the responses of surveys from the three groups: experts group in sustainability, waste management and behavioural science, a population group of Leoben and that of Barcelona. Out of these results the following conclusions can be deduced:

The population groups perceive internal drivers such as “Beliefs and values”, “Environmental concern” and “Habits” as the most important non-demographic drivers. Although, the group of experts sees the driver “Beliefs and values” as second most important driver, they perceive “Convenience of the collection system” clearly to be most important non-demographic driver. This is also the factor, which waste management companies and governmental organisations can influence the most. The target should be, to not reinforce possibly existing internal barriers by a lack of convenience. Separate waste collection should be made as easy and convenient as possible so that it can become a daily routine without needing much additional effort. However, the perceived importance of the internal drivers of the population group should be more considered when the waste separation behaviour of a population wants to be improved. As these internal drivers are hard to be influenced a long-term strategy adjusted to the population is needed. For this a mixture of “Environmental education”, “Awareness Campaigns”, “Governmental regulations”, “Provided information” and possibly “Economic incentives” is needed. Target is to create a society which is aware of environmental issues and waste problems and that recognizes their own responsibility. If this awareness is then supported by a convenient collection system, good waste separation behaviour and therefore, also better collection and recycling quotes can be achieved. Comparing the priority vectors of the population groups of Barcelona and Leoben, it can be seen that those two groups have assigned very similar weightages to the non-demographic drivers. The only bigger differences occurred for the drivers “Environmental education” and “Habits”. Overall, it can be said, that their perceptions do not differ clearly from each other.

Of the demographic drivers, clearly the drivers “Level of education” and “Location” are seen as the most important ones by the questioned groups. “Level of education” seems to be perceived to be related to the non-demographic drivers “Environmental education” and

“Environmental concern”. The groups seem to believe that a higher understanding for environmental issues and for the importance of waste separation is related to a higher education. Because of this, and because knowledge and behaviour are absorbed easier by children, it is necessary to include “Environmental education” already in the early years of education. This way the complete population would obtain basic environmental knowledge and awareness.
“Location” is perceived to be so important because it is related to the type of collection system, which again leads back to the driver “Convenience of the collection system”. Convenience is the most important external driver and can be influenced easily. The objective should be to provide a convenient collection system, regardless of the location. It is clear, that not for all the areas the same collection systems can be provided, however, the provided collection systems should be as convenient as possible. When comparing the priority vectors of the two population groups it can be seen that these assigned weightages differ slightly stronger from each other than those for the non-demographic drivers. Especially the weightages of the drivers “Heritage and Culture”, “Personal barriers” and “Type of dwelling” differ strongly from each other. While “Type of dwelling” is not seen as very important by the participants of Barcelona, the other two mentioned drivers are significantly more important to them than to the participants of Leoben. This simply shows that there are still differences in perception between these two population groups.

Lastly, the ratings of the categories “non-demographic drivers” and “demographic drivers” show clearly that the non-demographic drivers are perceived as having more influence on waste separation behaviour.

6 Summary

To achieve a system that is closer to a circular economy, the collection of waste has to be improved, as to recycling something, it first needs to be collected. While the waste recycling infrastructure already is very highly developed in many countries of the European Union, the participation of the population (eg. their waste sorting behaviour) still shows a lot of potential for improvement. This study examines the major drivers that influence the waste separation behaviour of a population.

First an extensive literature research was conducted, with the target to identify drivers that were already discovered in former studies. These drivers were then divided in two categories: the non-demographic drivers and the demographic drivers. Each of the categories included 12 drivers. These drivers, divided in their categories, were then presented to three groups: experts group in sustainability, waste management and behavioural science, a population group of Leoben and that of Barcelona. These groups were asked to rank the drivers within their proper categories. Furthermore, they were asked to rate the categories of “non-demographic drivers” and “demographic drivers” in percent, according to their perceived influence on waste separation behavoiur. The obtained data was then processed in MS Excel in pairwise comparison matrices, which are a part of the Analytich Hierarchy Process, which is a form of Multi Criteria Decision Analysis. This process is used to structure complex deciscion making problems by comparing criteria (drivers) pairwise. By this process, weightages for the drivers were obtained, according to the perception the group has on how important a driver is for waste separation behavhiour.

The results show, that in total the most important drivers are internal drivers like “Beliefs and values”, “Environmental concern” and “Habits”. However, for the experts group the most important driver is “Convenience of the collection system”. In summary it can be said, that it is important to create an environmentally conscious society which develops environmentally friendly behaviour. This society should then be supported with with a convenient collection system.

The most important demographic drivers are “Level of education” and “Location”. Level of edcuation is being related to the knowledge about environmental issues and the understanding of the recycling process. This means, target should be to educate people in their early years of education about this topics. So that not only people with higher educational levels obtain access to environmentally related knowledge. This way a more environmentally conscious society could be built. The driver “Location” seems to be most important because it defines the collection system a person participates in. Therefore, it defines the convenience a person experiences while participating in waste separation. Like mentioned before, the target should be to support all members of a waste conscioius

society with a convenient collection system, to facilitate the transition of environmentally friendly attitude into actual behaviour.

The comparison of the ratings for the non-demographic drivers of the population groups did not show a significant difference in perception. However, the perceptions of the demographic drivers differ more strongly. This reveals, that the two populations still have differences in their perception about waste separation.

Another important fact is, that all the groups see the non-demographic drivers as clearly more important than the demographic ones. Especially the consent between all the questioned groups (Barcelona, Leoben and experts) is remarkable.

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8 Registers

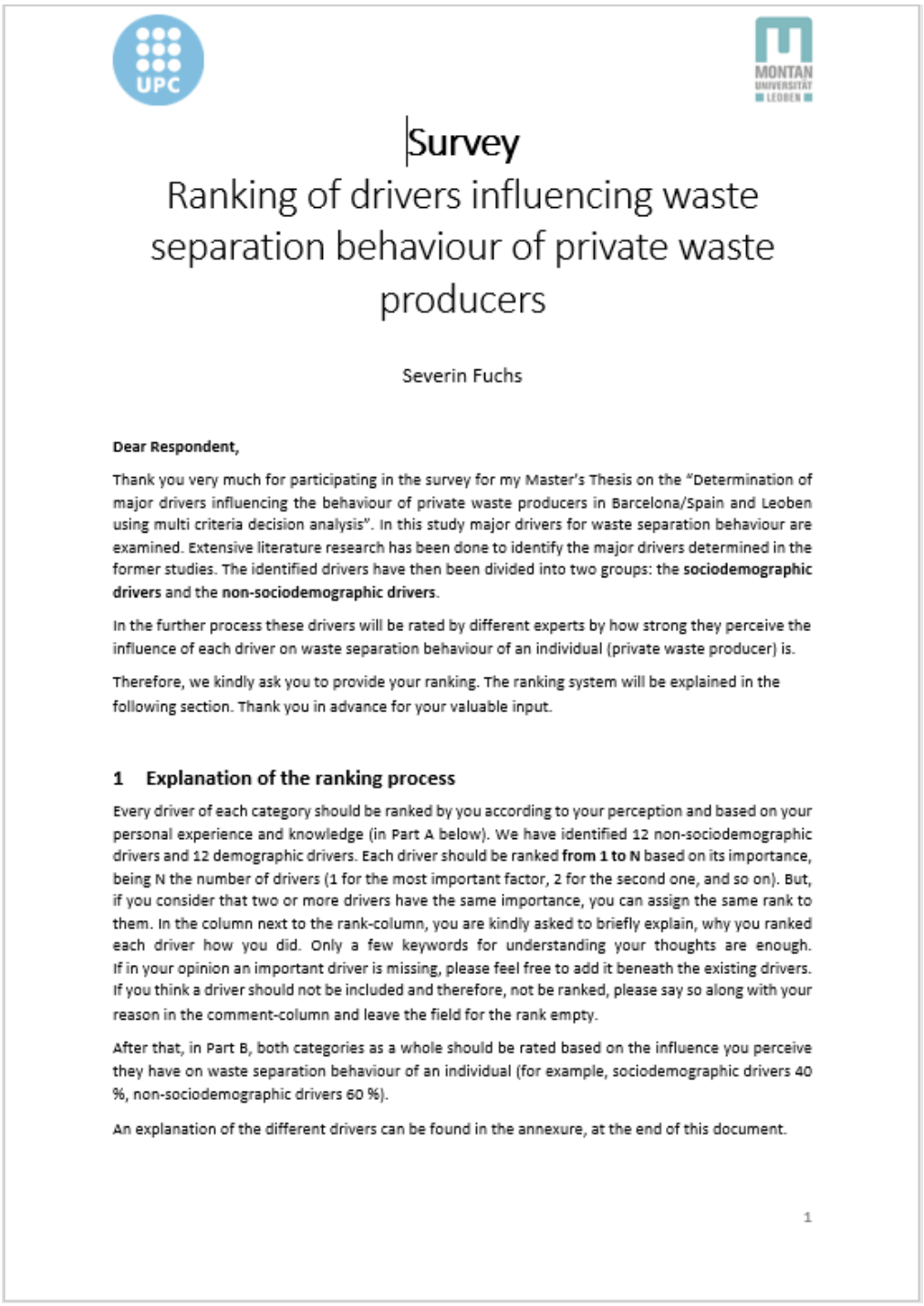
8.1 Figures

8.2 Tables

8.3 Equations

9 Annexures

A] Form for the experts survey



Survey

Ranking of drivers influencing waste separation behaviour of private waste producers

Severin Fuchs

Dear Respondent,

Thank you very much for participating in the survey for my Master's Thesis on the "Determination of major drivers influencing the behaviour of private waste producers in Barcelona/Spain and Leoben using multi criteria decision analysis". In this study major drivers for waste separation behaviour are examined. Extensive literature research has been done to identify the major drivers determined in the former studies. The identified drivers have then been divided into two groups: the **sociodemographic drivers** and the **non-sociodemographic drivers**.

In the further process these drivers will be rated by different experts by how strong they perceive the influence of each driver on waste separation behaviour of an individual (private waste producer) is.

Therefore, we kindly ask you to provide your ranking. The ranking system will be explained in the following section. Thank you in advance for your valuable input.

1 Explanation of the ranking process

Every driver of each category should be ranked by you according to your perception and based on your personal experience and knowledge (in Part A below). We have identified 12 non-sociodemographic drivers and 12 demographic drivers. Each driver should be ranked **from 1 to N** based on its importance, being N the number of drivers (1 for the most important factor, 2 for the second one, and so on). But, if you consider that two or more drivers have the same importance, you can assign the same rank to them. In the column next to the rank-column, you are kindly asked to briefly explain, why you ranked each driver how you did. Only a few keywords for understanding your thoughts are enough. If in your opinion an important driver is missing, please feel free to add it beneath the existing drivers. If you think a driver should not be included and therefore, not be ranked, please say so along with your reason in the comment-column and leave the field for the rank empty.

After that, in Part B, both categories as a whole should be rated based on the influence you perceive they have on waste separation behaviour of an individual (for example, sociodemographic drivers 40 %, non-sociodemographic drivers 60 %).

An explanation of the different drivers can be found in the annexure, at the end of this document.

1

2 The ranking

2.1 Non-demographic factors (12)

Part A: Ranking the drivers

Drive	Rank	Short explanation of the rating
Appearance and design of infrastructure		
Awareness campaigns		
Beliefs and values		
Convenience of the collection system		
Economic incentives		
Environmental concern		
Environmental education		
Governmental regulations		
Habits		
Provided information		
Social pressure		
Trust in system		

Part B: Rating the category

Please, rate this category (%): Klicken oder tippen Sie hier, um Text einzugeben.

2.2 Demographic factors (12)

Driver	Rank	Short explanation of the rating
Age		
Employment status		
Family situation		
Gender		
Heritage and culture		
Income		
Level of education		
Location		
Personal barriers		
Political preferences		
Social status		
Type of dwelling		

Part B: Rating the category

Please, rate this category (%): Klicken oder tippen Sie hier, um Text einzugeben.

Definitions of non-sociodemographic drivers

Driver	Meaning
Appearance and design of infrastructure	Design of the containers and collection points (also technical aspects), as well as tidiness and optical appearance of the collection facilities.
Awareness campaigns	The frequency and the intensity of awareness measures which are set in a certain area to motivate population to participate in waste separation.
Beliefs and values (including personal moral norms)	Internal beliefs and values an individual orientates itself with. This includes altruistic beliefs, willingness to participate in a society, and perception of own responsibility. Also included are personal moral norms, which represent a certain expectation towards the own behaviour.
Convenience of the collection system	All aspects which make participation in waste separation more or less convenient for an individual. It includes type of collection system, distance from residence to the collection point, availability of infrastructure, which materials are collected separately, etc.
Economic incentives	Real incentives which can be earned by a certain behaviour like money, discounts or free services. Also represents the stimulus of lower costs when a certain behaviour (waste separation) is performed. In other words, avoiding costs and penalties could also be seen as an economic incentive; thus, included under this driver.
Environmental concern	Individual's concern about the environment and the felt importance of pro-environmental actions.
Environmental education	Environmental knowledge a person has. This can come from school, personal or professional education.
Governmental regulations	Restrictions, laws and guidelines which are set by the government. It not only includes the amount and type of these regulations but also their effectiveness and controllability.
Habits	Learned, routine behaviour which is hard to change, because mostly it is developed while growing up.
Provided Information	All the valuable information that is provided to make waste separation easier for the population. This includes information about where to find collection points, waste collection times in kerbside collection systems, how to separate waste correctly and in which container to put certain materials and products.
Social pressure	Pressure an individual receives by its social surrounding. This can come from family members, friends, work colleagues or members of free time associations.
Trust in system	Trust an individual has in the process that happens after waste separation by the population. This starts by the collection of the waste from the containers and ends by the perceived usefulness and commitment to the application of secondary raw materials. Also the trust in the effectiveness of participation in waste separation is included in this point.

Definitions of sociodemographic drivers

Driver	Meaning
Age	The physical age of the person.
Employment status	Different forms of employment (employees, worker, self-employed persons) as well the different forms of not employed people (students, retired persons, unemployed persons)
Family Situation	Living with or without partner and whether or not children are living in the household
Gender	Gender the person identifies with.
Heritage and culture	Where the participant comes from and his / her cultural background
Income	All sources of income and in general wealth of a household.
Level of education	Completed level of school education of the respondent is meant. It includes "no completed education", "completed compulsory education", "completed higher education" and "completed university degree".
Location	Location of the residence of the respondent is meant. It differs between "rural environment", "suburban environment" and "urban environment".
Personal barriers	Barriers due to physical disabilities, whether they are the result of age, injuries or exist since birth.
Political preferences	Political tendencies of respondents
Social status	Social power which comes with gaining a certain level of social responsibility. This can be obtained by reaching a certain level of the hierarchy in a company (leader of a team, head of department, location manager, CEO, etc.) or by being a person in public practice (major, part of municipal council, governor, leader of an association etc.)
Type of dwelling	Different types of housing such as single family houses, semi-detached houses, multi-occupancy houses, etc.

Suggestions/Comments

If you have any suggestions or comments, please indicate them below:
Klicken oder tippen Sie hier, um Text einzugeben.

Thank you for your valuable input!

B] Results of the experts survey

Rankings of the experts

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1			*Lluc Canals*	*Jordi Segalàs*	*Katharina Gangl*	*Michele Giavini*	*Karl Hagspiel*	*Maria Calaf*	*Melanie Jaeger-Erben*	*Roland Pomberger*	*highest rank*	*lowest rank*	*variance*	*MEAN*
2	**Non-demographic factors**													
3	ND1	Appearance and design of infrastructure	11	11	2	4	12	12	1	3	1	12	4,58	7,00
4	ND2	Awareness campaigns	10	12	*7*	*3*	*8*	*8*	*10*	*4*	*3*	*12*	2,86	7,75
5	ND3	Beliefs and values	11	1	8	2	1	7	6	1	1	11	3,64	4,63
6	ND4	Convenience of the collection	5	6	1	1	9	2	2	2	1	9	2,69	3,50
7	ND5	Economic incentives	6	7	10	3	2	1	9	9	1	10	3,26	5,88
8	ND6	Environmental concern	7	3	3	2	5	3	7	8	2	8	2,17	4,75
9	ND7	Environmental education	9	4	4	3	5	5	7	5	3	9	1,79	5,25
10	ND8	Governmental regulations	1	8	11	3	7	4	4	7	1	11	3,00	5,63
11	ND9	Habits	8	2	5		2	10	3	10	2	10	3,33	5,71
12	ND10	Provided information	3	9	6		11	11	7	11	3	11	2,86	8,29
13	ND11	Social pressure	2	10	9	2	4	9	5	6	2	10	2,98	5,88
14	ND12	Trust in system	4	5	7	2	10	6	8	12	2	12	3,03	6,75
15		Social implication	2								2	2	0,00	
16		RATE (%)			*70*	*80*	*60*	*80*		*70*	*80*	*60*	*7,48*	*72,00*
17														
18	**Demographic factors**													
19	D1	Age	2	12	1	4	11	7		11	1	12	4,26	6,86
20	D2	Employment status	6	6		4	4	9	4	1	1	9	2,29	4,86
21	D3	Family situation	2	5		3	6	8	1	6	1	8	2,32	4,43
22	D4	Gender	6	8	2	4	10	5	5		2	10	2,43	5,71
23	D5	Heritage and culture	3	7		3	2	4	1	11	1	11	3,20	4,43
24	D6	Income	6	9		3	3	6	6	1	1	9	2,47	4,86
25	D7	Level of education	4	4		2	1	2	5	11	1	11	3,09	4,14
26	D8	Location (urban, suburban, rural)	1	1		2	9		2	6	1	9	2,99	3,50
27	D9	Personal barriers	6	2		3	12	1	3		1	12	3,69	4,50
28	D10	Political preferences	5	3		3	8	10	7	1	1	10	2,96	5,29
29	D11	Social status	6	11		3	4	3	6	1	1	11	3,00	4,86
30	D12	Type of dwelling	6	10		1	7	4	2	11	1	11	3,52	5,86
31		RATE (%)			*30*	*20*	*40*	*20*		*30*	*40*	*20*	*7,48*	*28,00*

Pairwise comparison matrix and priority vector of the non-demographic drivers

A/B	ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11	ND12
ND1	1	1,75	0,2963	0,22222	0,470588	0,307692	0,36364	0,4211	0,4375	2,286	0,47059	0,8
ND2	0,571429	1	0,24242	0,19048	0,347826	0,25	0,28571	0,32	0,32941	1,536	0,34783	0,5
ND3	3,375	4,125	1	0,47059	2,25	1,125	1,625	2	2,08929	4,661	2,25	3,125
ND4	4,5	5,25	2,125	1	3,375	2,25	2,75	3,125	3,21429	5,786	3,375	4,25
ND5	2,125	2,875	0,44444	0,2963	1	0,470588	0,61538	0,8	0,86154	3,411	1	1,875
ND6	3,25	4	0,88889	0,44444	2,125	1	1,5	1,875	1,96429	4,536	2,125	3
ND7	2,75	3,5	0,61538	0,36364	1,625	0,666667	1	1,375	1,46429	4,036	1,625	2,5
ND8	2,375	3,125	0,5	0,32	1,25	0,533333	0,72727	1	1,08929	3,661	1,25	2,125
ND9	2,285714	3,03571	0,47863	0,31111	1,160714	0,509091	0,68293	0,918	1	3,571	1,16071	2,03571
ND10	0,4375	0,65116	0,21456	0,17284	0,293194	0,220472	0,24779	0,2732	0,28	1	0,29319	0,39437
ND11	2,125	2,875	0,44444	0,2963	1	0,470588	0,61538	0,8	0,86154	3,411	1	1,875
ND12	1,25	2	0,32	0,23529	0,533333	0,333333	0,4	0,4706	0,49123	2,536	0,53333	1
Sum	*26,0446*	*34,1869*	*7,57007*	*4,3232*	*15,4307*	*8,13677*	*10,8131*	*13,378*	*14,0826*	*40,43*	*15,4307*	*23,4801*

Standard criteria matrix													**Vector weight of criteria [W]**	**Matrix consistency**	
	ND1	**ND2**	**ND3**	**ND4**	**ND5**	**ND6**	**ND7**	**ND8**	**ND9**	**ND10**	**ND11**	**ND12**		Weight vector [Ws]=[C]x[W]	Consistency vector [Cons]=[Ws]/[W]
ND1	0,04	0,05	0,04	0,05	0,03	0,04	0,03	0,03	0,03	0,06	0,03	0,03	**0,04**	0,468222064	12,06460541
ND2	0,02	0,03	0,03	0,04	0,02	0,03	0,03	0,02	0,02	0,04	0,02	0,02	**0,03**	0,338323787	12,07952137
ND3	0,13	0,12	0,13	0,11	0,15	0,14	0,15	0,15	0,15	0,12	0,15	0,13	**0,13**	1,651327837	12,25020999
ND4	0,17	0,15	0,28	0,23	0,22	0,28	0,25	0,23	0,23	0,14	0,22	0,18	**0,22**	2,64765067	12,25477395
ND5	0,08	0,08	0,06	0,07	0,06	0,06	0,06	0,06	0,06	0,08	0,06	0,08	**0,07**	0,831822364	12,13617664
ND6	0,12	0,12	0,12	0,10	0,14	0,12	0,14	0,14	0,14	0,11	0,14	0,13	**0,13**	1,549557997	12,24415262
ND7	0,11	0,10	0,08	0,08	0,11	0,08	0,09	0,10	0,10	0,10	0,11	0,11	**0,10**	1,191748748	12,20783054
ND8	0,09	0,09	0,07	0,07	0,08	0,07	0,07	0,07	0,08	0,09	0,08	0,09	**0,08**	0,963904333	12,16747185
ND9	0,09	0,09	0,06	0,07	0,08	0,06	0,06	0,07	0,07	0,09	0,08	0,09	**0,08**	0,914342186	12,1562819
ND10	0,02	0,02	0,03	0,04	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,02	**0,02**	0,276574553	12,11215174
ND11	0,08	0,08	0,06	0,07	0,06	0,06	0,06	0,06	0,06	0,08	0,06	0,08	**0,07**	0,831822364	12,13617664
ND12	0,05	0,06	0,04	0,05	0,03	0,04	0,04	0,04	0,03	0,06	0,03	0,04	**0,04**	0,52877678	12,07143564
Sum	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*		

Average consistency (c)	12,15673236
Consistency index Ci=(c-n)/(n-1)	0,014248396
Consistency ratio Cr=Ci/Ri	**0,009252205**

Pairwise comparison matrix and priority vector of the demographic drivers

A/B	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
D1	1	0,333333	0,291667	0,466667	0,291667	0,333333	0,269231	0,229508	0,297872	0,388889	0,333333	0,5
D2	3	1	0,7	1,857143	0,7	1	0,583333	0,424242	0,736842	1,428571	1	2
D3	3,428571	1,428571	1	2,285714	1	1,428571	0,777778	0,518519	1,071429	1,857143	1,428571	2,428571
D4	2,142857	0,538462	0,4375	1	0,4375	0,538462	0,388889	0,311111	0,451613	0,7	0,538462	1,142857
D5	3,428571	1,428571	1	2,285714	1	1,428571	0,777778	0,518519	1,071429	1,857143	1,428571	2,428571
D6	3	1	0,7	1,857143	0,7	1	0,583333	0,424242	0,736842	1,428571	1	2
D7	3,714286	1,714286	1,285714	2,571429	1,285714	1,714286	1	0,608696	1,357143	2,142857	1,714286	2,714286
D8	4,357143	2,357143	1,928571	3,214286	1,928571	2,357143	1,642857	1	2	2,785714	2,357143	3,357143
D9	3,357143	1,357143	0,933333	2,214286	0,933333	1,357143	0,736842	0,5	1	1,785714	1,357143	2,357143
D10	2,571429	0,7	0,538462	1,428571	0,538462	0,7	0,466667	0,358974	0,56	1	0,7	1,571429
D11	3	1	0,7	1,857143	0,7	1	0,583333	0,424242	0,736842	1,428571	1	2
D12	2	0,5	0,411765	0,875	0,411765	0,5	0,368421	0,297872	0,424242	0,636364	0,5	1
Sum	*35*	*13,35751*	*9,927012*	*21,9131*	*9,927012*	*13,35751*	*8,178462*	*5,615926*	*10,44425*	*17,43954*	*13,35751*	*23,5*

Standard criteria matrix													**Vector weight of criteria [W]**
	ND1	**ND2**	**ND3**	**ND4**	**ND5**	**ND6**	**ND7**	**ND8**	**ND9**	**ND10**	**ND11**	**ND12**	
ND1	0,03	0,02	0,03	0,02	0,03	0,02	0,03	0,04	0,03	0,02	0,02	0,02	**0,03**
ND2	0,09	0,07	0,07	0,08	0,07	0,07	0,07	0,08	0,07	0,08	0,07	0,09	**0,08**
ND3	0,10	0,11	0,10	0,10	0,10	0,11	0,10	0,09	0,10	0,11	0,11	0,10	**0,10**
ND4	0,06	0,04	0,04	0,05	0,04	0,04	0,05	0,06	0,04	0,04	0,04	0,05	**0,05**
ND5	0,10	0,11	0,10	0,10	0,10	0,11	0,10	0,09	0,10	0,11	0,11	0,10	**0,10**
ND6	0,09	0,07	0,07	0,08	0,07	0,07	0,07	0,08	0,07	0,08	0,07	0,09	**0,08**
ND7	0,11	0,13	0,13	0,12	0,13	0,13	0,12	0,11	0,13	0,12	0,13	0,12	**0,12**
ND8	0,12	0,18	0,19	0,15	0,19	0,18	0,20	0,18	0,19	0,16	0,18	0,14	**0,17**
ND9	0,10	0,10	0,09	0,10	0,09	0,10	0,09	0,09	0,10	0,10	0,10	0,10	**0,10**
ND10	0,07	0,05	0,05	0,07	0,05	0,05	0,06	0,06	0,05	0,06	0,05	0,07	**0,06**
ND11	0,09	0,07	0,07	0,08	0,07	0,07	0,07	0,08	0,07	0,08	0,07	0,09	**0,08**
ND12	0,06	0,04	0,04	0,04	0,04	0,04	0,05	0,05	0,04	0,04	0,04	0,04	**0,04**
Sum	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Matrix consistency	
Weight vector [Ws]=[C]x[W]	Consistency vector [Cons]=[Ws]/[W]
0,33046452	12,03961729
0,925182154	12,06068321
1,232313299	12,07721397
0,552443621	12,03369373
1,232313299	12,07721397
0,925182154	12,06068321
1,476666152	12,08322689
2,076295053	12,0823287
1,174675336	12,07495677
0,705731208	12,04369963
0,925182154	12,06068321
0,511440555	12,03202927
Average consistency (c)	12,06050249
Consistency index Ci=(c-n)/(n-1	0,005500226
Consistency ratio Cr=Ci/Ri	**0,003571575**

C] Results of the population survey in Leoben

Rankings of the participants

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2	**Non-demographic factors**		1	2	3	4	5	6	7	8	9	10	11	12	sum	highest rank	lowest rank	variance	*MEAN*
3	ND1	Appearance and design of infrastructure	4	2	4	4	7	6	2	1	3	6	2	2	43	1	12	3,20	6,09
4	ND2	Awareness campaigns	4	1	5	3	7	9	3	0	5	0	7	1	45	1	12	3,12	6,16
5	ND3	Beliefs and values	11	5	8	2	2	4	3	3	0	1	2	3	44	1	12	3,48	4,55
6	ND4	Convenience of the collection	10	8	6	4	1	2	2	2	4	0	2	4	45	1	12	3,70	4,73
7	ND5	Economic incentives	5	5	5	4	3	5	1	5	0	5	0	6	44	1	12	3,65	5,91
8	ND6	Environmental concern	8	5	8	8	1	2	2	2	0	3	3	2	44	1	12	3,43	4,73
9	ND7	Environmental education	4	3	6	4	3	5	3	2	3	5	2	3	43	1	12	3,40	6,07
10	ND8	Governmental regulations	7	7	3	4	6	1	1	3	4	3	3	1	43	1	11	3,47	5,21
11	ND9	Habits	14	8	7	3	1	1	1	1	1	3	1	3	44	1	12	3,60	3,98
12	ND10	Provided information	5	6	3	5	5	2	8	0	2	4	4	1	45	1	12	3,31	5,62
13	ND11	Social pressure	4	2	3	11	2	5	6	4	5	0	0	3	45	1	12	2,89	5,69
14	ND12	Trust in system	6	6	2	6	2	4	3	4	2	0	3	4	42	1	12	3,58	5,57
15		Social implication													0				
16		RATE (%)													0	*80.00*	*30.00*	*15.00*	*59.63*
17																			
18	**Demographic factors**																		
19	D1	Age	2	6	4	5	4	6	6	1	6	3	1	0	44	1	11	2,77	5,61
20	D2	Employment status	4	3	5	3	5	5	5	5	2	5	1	1	44	1	12	2,99	5,86
21	D3	Family situation	6	5	3	4	5	4	4	1	6	3	1	3	45	1	12	3,39	5,71
22	D4	Gender	6	4	3	2	3	4	0	1	2	1	6	12	44	1	12	4,29	7,18
23	D5	Heritage and culture	4	8	5	4	4	2	3	3	1	4	2	4	44	1	12	3,59	5,61
24	D6	Income	2	2	4	2	6	3	3	7	4	4	3	3	43	1	12	3,10	6,88
25	D7	Level of education	10	7	8	2	4	1	3	4	1	1	0	3	44	1	12	3,28	4,32
26	D8	Location (urban, suburban, rural)	6	9	5	4	5	3	3	2	2	1	1	3	44	1	12	3,27	4,77
27	D9	Personal barriers	5	1	4	5	2	6	5	5	5	2	4	1	45	1	12	3,11	6,24
28	D10	Political preferences	3	2	5	3	5	3	7	3	4	3	3	3	44	1	12	3,18	6,48
29	D11	Social status	5	5	4	3	6	5	2	5	2	3	2	3	45	1	12	3,34	5,76
30	D12	Type of dwelling	5	9	3	9	4	3	2	1	0	1	5	3	45	1	11	3,51	5,09
31		RATE (%)													0	*70.00*	*20.00*	*15.00*	*40.37*
32																			

Pairwise comparison matrix and priority vector of the non-demographic drivers

A/B	ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11	ND12
ND1	1	1,06253	0,39253	0,42378	0,844643	0,422699	0,97727	0,5309	0,32095	0,68	0,71218	0,65721
ND2	0,941148	1	0,38313	0,41284	0,802269	0,411814	0,92099	0,5138	0,31464	0,652	0,68182	0,63126
ND3	2,547569	2,6101	1	1,18788	2,363636	1,181818	2,52431	1,6638	0,63768	2,077	2,14343	2,02597
ND4	2,35969	2,42222	0,84184	1	2,175758	0,993976	2,33643	1,476	0,56946	1,889	1,95556	1,8381
ND5	1,183932	1,24646	0,42308	0,45961	1	0,458333	1,16068	0,5883	0,34109	0,777	0,81954	0,74757
ND6	2,365751	2,42828	0,84615	1,00606	2,181818	1	2,34249	1,482	0,57143	1,895	1,96162	1,84416
ND7	1,023256	1,08579	0,39615	0,428	0,861566	0,426895	1	0,5375	0,32336	0,691	0,72418	0,66741
ND8	1,883721	1,94625	0,60102	0,67752	1,699789	0,67475	1,86047	1	0,44802	1,413	1,47959	1,36213
ND9	3,115751	3,17828	1,56818	1,75606	2,931818	1,75	3,09249	2,232	1	2,645	2,71162	2,59416
ND10	1,470801	1,53333	0,48152	0,52941	1,286869	0,527719	1,44755	0,7078	0,37808	1	1,06667	0,95166
ND11	1,404134	1,46667	0,46654	0,51136	1,220202	0,509784	1,38088	0,6759	0,36878	0,937	1	0,89489
ND12	1,521595	1,58413	0,49359	0,54404	1,337662	0,542254	1,49834	0,7341	0,38548	1,051	1,11746	1
Sum	*20,8173*	*21,5641*	*7,89372*	*8,93658*	*18,706*	*8,90004*	*20,5419*	*12,142*	*5,65897*	*15,71*	*16,3736*	*15,2145*

Standard criteria matrix

	ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11	ND12
ND1	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,04	0,06	0,04	0,04	0,04
ND2	0,05	0,05	0,05	0,05	0,04	0,05	0,04	0,04	0,06	0,04	0,04	0,04
ND3	0,12	0,12	0,13	0,13	0,13	0,13	0,12	0,14	0,11	0,13	0,13	0,13
ND4	0,11	0,11	0,11	0,11	0,12	0,11	0,11	0,12	0,10	0,12	0,12	0,12
ND5	0,06	0,06	0,05	0,05	0,05	0,05	0,06	0,05	0,06	0,05	0,05	0,05
ND6	0,11	0,11	0,11	0,11	0,12	0,11	0,11	0,12	0,10	0,12	0,12	0,12
ND7	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,04	0,06	0,04	0,04	0,04
ND8	0,09	0,09	0,08	0,08	0,09	0,08	0,09	0,08	0,08	0,09	0,09	0,09
ND9	0,15	0,15	0,20	0,20	0,16	0,20	0,15	0,18	0,18	0,17	0,17	0,17
ND10	0,07	0,07	0,06	0,06	0,07	0,06	0,07	0,06	0,07	0,06	0,07	0,06
ND11	0,07	0,07	0,06	0,06	0,07	0,06	0,07	0,06	0,07	0,06	0,06	0,06
ND12	0,07	0,07	0,06	0,06	0,07	0,06	0,07	0,06	0,07	0,07	0,07	0,07
Sum	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Vector weight of criteria [W]	**Matrix consistency**	
	Weight vector [Ws]=[C]x[W]	Consistency vector [Cons]=[Ws]/[W]
0,05	0,566083858	12,0209846
0,05	0,543894772	12,02244323
0,13	1,53690058	12,04578075
0,11	1,373369646	12,04136454
0,05	0,639503742	12,01794513
0,11	1,37850137	12,04153066
0,05	0,574753546	12,02045652
0,09	1,023749489	12,02849673
0,17	2,069722441	12,04976659
0,06	0,778254469	12,01910269
0,06	0,743054205	12,01816912
0,07	0,806137713	12,02001344
1		

Average consistency (c)	12,02883783
Consistency index Ci=(c-n)/(n-1)	0,002621621
Consistency ratio Cr=Ci/Ri	**0,001702351**

Pairwise comparison matrix and priority vector of the demographic drivers

A/B	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
D1	1	1,25	1,097475	2,568182	1	2,270085	0,435644	0,54321	1,630808	1,863636	1,141919	0,655846
D2	0,8	1	0,86766	2,318182	0,8	2,020085	0,392857	0,478261	1,380808	1,613636	0,902461	0,56346
D3	0,911183	1,152525	1	2,470707	0,911183	2,17261	0,417898	0,515894	1,533333	1,766162	1,044444	0,616438
D4	0,389381	0,431373	0,404742	1	0,389381	0,770358	0,258824	0,293333	0,516163	0,586667	0,412157	0,323318
D5	1	1,25	1,097475	2,568182	1	2,270085	0,435644	0,54321	1,630808	1,863636	1,141919	0,655846
D6	0,440512	0,495029	0,460276	1,298097	0,440512	1	0,280462	0,321441	0,610025	0,711011	0,469888	0,357803
D7	2,295455	2,545455	2,392929	3,863636	2,295455	3,565539	1	1,454545	2,926263	3,159091	2,437374	1,770707
D8	1,840909	2,090909	1,938384	3,409091	1,840909	3,110994	0,6875	1	2,471717	2,704545	1,982828	1,316162
D9	0,613193	0,724214	0,652174	1,937374	0,613193	1,639276	0,341733	0,404577	1	1,232828	0,671642	0,463918
D10	0,536585	0,619718	0,5662	1,704545	0,536585	1,406448	0,316547	0,369748	0,811143	1	0,580815	0,418693
D11	0,875719	1,108081	0,957447	2,426263	0,875719	2,128165	0,410278	0,50433	1,488889	1,721717	1	0,6
D12	1,524747	1,774747	1,622222	3,092929	1,524747	2,794832	0,564746	0,759785	2,155556	2,388384	1,666667	1
Sum	*12,22768*	*14,44205*	*13,05698*	*28,65719*	*12,22768*	*25,14848*	*5,542132*	*7,188334*	*18,15551*	*20,61131*	*13,45211*	*8,742192*

Standard criteria matrix

	ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11	ND12
ND1	0,08	0,09	0,08	0,09	0,08	0,09	0,08	0,08	0,09	0,09	0,08	0,08
ND2	0,07	0,07	0,07	0,08	0,07	0,08	0,07	0,07	0,08	0,08	0,07	0,06
ND3	0,07	0,08	0,08	0,09	0,07	0,09	0,08	0,07	0,08	0,09	0,08	0,07
ND4	0,03	0,03	0,03	0,03	0,03	0,03	0,05	0,04	0,03	0,03	0,03	0,04
ND5	0,08	0,09	0,08	0,09	0,08	0,09	0,08	0,08	0,09	0,09	0,08	0,08
ND6	0,04	0,03	0,04	0,05	0,04	0,04	0,05	0,04	0,03	0,03	0,03	0,04
ND7	0,19	0,18	0,18	0,13	0,19	0,14	0,18	0,20	0,16	0,15	0,18	0,20
ND8	0,15	0,14	0,15	0,12	0,15	0,12	0,12	0,14	0,14	0,13	0,15	0,15
ND9	0,05	0,05	0,05	0,07	0,05	0,07	0,06	0,06	0,06	0,06	0,05	0,05
ND10	0,04	0,04	0,04	0,06	0,04	0,06	0,06	0,05	0,04	0,05	0,04	0,05
ND11	0,07	0,08	0,07	0,08	0,07	0,08	0,07	0,07	0,08	0,08	0,07	0,07
ND12	0,12	0,12	0,12	0,11	0,12	0,11	0,10	0,11	0,12	0,12	0,12	0,11
Sum	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Vector weight of criteria [W]
0,08
0,07
0,08
0,03
0,08
0,04
0,17
0,14
0,06
0,05
0,08
0,12
1

Matrix consistency	
Weight vector [Ws]=[C]x[W]	Consistency vector [Cons]=[Ws]/[W]
1,013305633	12,05863417
0,854253468	12,04493888
0,947681667	12,05311804
0,403415545	12,03904576
1,013305633	12,05863417
0,467151101	12,03174476
2,106950328	12,08262144
1,677174558	12,0842604
0,670774502	12,03164162
0,583645983	12,02847089
0,919138308	12,05061401
1,405279759	12,07916354
Average consistency (c)	12,05357397
Consistency index Ci=(c-n)/(n-1	0,004870361
Consistency ratio Cr=Ci/Ri	**0,003162572**

D] Results of the population survey in Barcelona

Rankings of the participants

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1																			
2	**Non-demographic factors**		1	2	3	4	5	6	7	8	9	10	11	12	sum	highest rank	lowest rank	variance	*MEAN*
3	ND1	Appearance and design of infrastructure	8	4	7	2	5	4	0	3	1	3	1	5	43	1	12	3,71	5,30
4	ND2	Awareness campaigns	9	4	6	3	4	3	3	0	1	3	3	4	43	1	12	3,78	5,26
5	ND3	Beliefs and values	20	9	2	1	2	1	2	0	0	1	3	2	43	1	12	3,53	3,37
6	ND4	Convenience of the collection	18	8	3	1	4	0	0	1	1	2	2	4	44	1	12	3,90	3,95
7	ND5	Economic incentives	10	3	6	4	4	2	4	1	2	2	0	5	43	1	12	3,64	5,02
8	ND6	Environmental concern	17	7	5	3	2	0	2	2	1	1	0	3	43	1	12	3,35	3,56
9	ND7	Environmental education	14	6	6	2	3	4	2	1	1	1	0	4	44	1	12	3,46	4,09
10	ND8	Governmental regulations	12	5	8	1	3	1	4	4	1	2	1	2	44	1	11	3,40	4,43
11	ND9	Habits	13	13	4	2	0	1	3	1	1	2	1	2	43	1	12	3,37	3,67
12	ND10	Provided information	10	4	6	1	4	1	5	4	3	1	2	2	43	1	12	3,48	5,02
13	ND11	Social pressure	9	5	3	3	3	3	1	1	6	3	2	3	42	1	12	3,78	5,48
14	ND12	Trust in system	17	2	8	1	2	1	2	1	2	0	0	7	43	1	12	4,04	4,40
15		Social implication													0				
16		RATE (%)													0	*80.00*	*10.00*	*16.22*	*56.83*
17																			
18	**Demographic factors**																		
19	D1	Age	1	5	3	5	4	6	2	6	0	4	1	6	43	5	5	3,32	6,53
20	D2	Employment status	3	8	5	4	1	0	5	3	2	1	2	9	43	1	12	3,99	6,33
21	D3	Family situation	3	5	8	0	5	2	4	3	3	2	1	7	43	1	12	3,68	6,23
22	D4	Gender	7	2	2	2	1	4	2	2	2	0	3	16	43	1	12	4,32	7,60
23	D5	Heritage and culture	4	9	9	5	3	2	1	2	1	2	2	4	44	1	12	3,52	4,95
24	D6	Income	3	4	5	7	4	1	0	2	4	3	2	8	43	1	12	3,84	6,51
25	D7	Level of education	11	8	4	3	3	3	1	1	1	1	0	7	43	1	12	3,93	4,70
26	D8	Location (urban, suburban, rural)	4	8	7	5	4	0	3	3	0	0	2	8	44	1	12	3,87	5,55
27	D9	Personal barriers	10	3	6	3	6	2	1	1	1	0	5	4	42	1	12	3,84	5,12
28	D10	Political preferences	3	3	4	5	7	2	3	2	1	1	4	8	43	1	12	3,72	6,60
29	D11	Social status	2	5	3	4	6	2	3	3	3	2	4	6	43	1	12	3,57	6,67
30	D12	Type of dwelling	4	10	2	4	1	4	3	0	2	2	3	8	43	1	11	4,06	6,12
31		RATE (%)													0	*90.00*	*20.00*	*16.22*	*43.17*
32																			

Pairwise comparison matrix and priority vector of the non-demographic drivers

A/B	ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11	ND12
ND1	1	0,95556	0,34127	0,42593	0,781818	0,364407	0,4522	0,5346	0,38053	0,782	1,17386	0,52439
ND2	1,046512	1	0,34677	0,43454	0,811321	0,37069	0,46191	0,5482	0,38739	0,811	1,22038	0,5375
ND3	2,930233	2,88372	1	1,58245	2,651163	1,186047	1,71882	2,0597	1,30233	2,651	3,1041	2,02326
ND4	2,34778	2,30127	0,63193	1	2,06871	0,716124	1,13636	1,4773	0,78117	2,069	2,52165	1,4408
ND5	1,27907	1,23256	0,37719	0,48339	1	0,40566	0,51751	0,6284	0,42574	1	1,45293	0,61429
ND6	2,744186	2,69767	0,84314	1,39641	2,465116	1	1,53277	1,8737	1,11628	2,465	2,91805	1,83721
ND7	2,211416	2,1649	0,5818	0,88	1,932347	0,652414	1	1,3409	0,70597	1,932	2,38528	1,30444
ND8	1,870507	1,824	0,4855	0,67692	1,591438	0,533709	0,74576	1	0,56902	1,591	2,04437	0,96481
ND9	2,627907	2,5814	0,76786	1,28013	2,348837	0,895833	1,41649	1,7574	1	2,349	2,80177	1,72093
ND10	1,27907	1,23256	0,37719	0,48339	1	0,40566	0,51751	0,6284	0,42574	1	1,45293	0,61429
ND11	0,851887	0,81942	0,32215	0,39657	0,688262	0,342694	0,41924	0,4891	0,35692	0,688	1	0,48057
ND12	1,906977	1,86047	0,49425	0,69406	1,627907	0,544304	0,76661	1,0365	0,58108	1,628	2,08084	1
Sum	*22,0955*	*21,5535*	*6,56906*	*9,7338*	*18,9669*	*7,41754*	*10,6852*	*13,374*	*8,03217*	*18,97*	*24,1562*	*13,0625*

Standard criteria matrix

	ND1	ND2	ND3	ND4	ND5	ND6	ND7	ND8	ND9	ND10	ND11	ND12
ND1	0,05	0,04	0,05	0,04	0,04	0,05	0,04	0,04	0,05	0,04	0,05	0,04
ND2	0,05	0,05	0,05	0,04	0,04	0,05	0,04	0,04	0,05	0,04	0,05	0,04
ND3	0,13	0,13	0,15	0,16	0,14	0,16	0,16	0,15	0,16	0,14	0,13	0,15
ND4	0,11	0,11	0,10	0,10	0,11	0,10	0,11	0,11	0,10	0,11	0,10	0,11
ND5	0,06	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,06	0,05
ND6	0,12	0,13	0,13	0,14	0,13	0,13	0,14	0,14	0,14	0,13	0,12	0,14
ND7	0,10	0,10	0,09	0,09	0,10	0,09	0,09	0,10	0,09	0,10	0,10	0,10
ND8	0,08	0,08	0,07	0,07	0,08	0,07	0,07	0,07	0,07	0,08	0,08	0,07
ND9	0,12	0,12	0,12	0,13	0,12	0,12	0,13	0,13	0,12	0,12	0,12	0,13
ND10	0,06	0,06	0,06	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,06	0,05
ND11	0,04	0,04	0,05	0,04	0,04	0,05	0,04	0,04	0,04	0,04	0,04	0,04
ND12	0,09	0,09	0,08	0,07	0,09	0,07	0,07	0,08	0,07	0,09	0,09	0,08
Sum	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

Vector weight of criteria [W]	**Matrix consistency**	
	Weight vector [Ws]=[C]x[W]	Consistency vector [Cons]=[Ws]/[W]
0,04	0,536106671	12,01856475
0,05	0,551660871	12,01794402
0,15	1,787891519	12,0460039
0,10	1,2598815	12,04289285
0,05	0,638784974	12,01692432
0,13	1,606176519	12,04715704
0,10	1,155317582	12,03913028
0,08	0,928533222	12,02766107
0,12	1,497597471	12,04701413
0,05	0,638784974	12,01692432
0,04	0,484422209	12,02130461
0,08	0,950781153	12,02899327
1		

Average consistency (c)	12,03087621
Consistency index Ci=(c-n)/(n-1)	0,002806928
Consistency ratio Cr=Ci/Ri	**0,001822681**

E] Project plan and costs

Timetable of the project

TASK	ASSIGNED TO	PROGRESS	START	END
Literature research				
Literature research drivers	Severin	100%	25.2.22	6.4.22
Reading Literature research driver	Mrs. Mhaddolkar, Prof. Cremades	100%	6.4.22	12.4.22
Restructuring Literature research (	Severin	100%	12.4.22	20.4.22
Reading Literature research driver	Mrs. Mhaddolkar, Prof. Cremades	100%	20.4.22	25.4.22
Literature research MCDA and AHP	Severin	100%	13.4.22	21.4.22
Reading Literature research MCDA	Mrs. Mhaddolkar, Prof. Cremades	100%	21.4.22	28.4.22
Expert rating				
Building form	Severin	100%	11.4.22	11.4.22
Rereading form	Mrs. Mhaddolkar, Prof. Cremades	100%	11.4.22	13.4.22
Corretion and sending out of form	Severin	100%	13.4.22	14.4.22
Rating of experts	Experts	100%	14.4.22	25.4.22
Evaluation of the answer	Severin	100%	22.4.22	2.5.22
Rereading of the evaluation	Mrs. Mhaddolkar, Prof. Cremades	100%	2.5.22	7.5.22
Correction of the evaluation	Severin	100%	7.5.22	9.5.22

Estimated costs of the project (hours out of memory)

Student			
Task	**Invested hours**	**Costs per hour**	**Total costs**
Finding literature for drivers	80 h	8 €/h	640,00 €
Writing literature research about drivers	160 h	8 €/h	1 280,00 €
Finding literature for MCDA and AHP	15 h	8 €/h	120,00 €
Writing literature research about MCDA and AHP	25 h	8 €/h	200,00 €
Building form for experts survey	10 h	8 €/h	80,00 €
Evaluation of the expert survey	10 h	8 €/h	80,00 €
Writing of the resulst of the expert survey	30 h	8 €/h	240,00 €
Building of the population surveys	35 h	8 €/h	280,00 €
Evaluation of the population surveys	30 h	8 €/h	240,00 €
Writing of the resulst of the expert survey	20 h	8 €/h	160,00 €
Writing theorethical parts	50 h	8 €/h	400,00 €
Interpretation and comparison	15 h	8 €/h	120,00 €
Writing of findings	50 h	8 €/h	400,00 €
Total	**530 h**		**4 240,00 €**
Supervisors			
Person	**Invested hours**	**Costs per hour**	**Total costs**
Mrs. Namrata Mhaddolkar	90 h	25 €/h	2 250,00 €
Prof. Cremades	60 h	25 €/h	1 500,00 €
Total	**150 h**		**3 750,00 €**
Other costs			
Laptop	5 month	16,66 €/month	83,30 €
Electricity			150,00 €
Total			233,30 €
Total project costs			**8 223,30 €**