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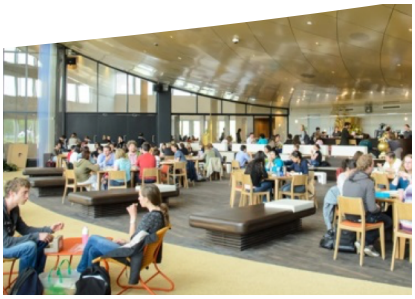


RETHINKING GREEN DRINKING AT WAGENINGEN UNIVERSITY

Comparative Multi Criteria Analysis and Stakeholder Analysis of the disposable and reusable cups

November – December 2018

Environmental Systems Analysis
Methods and Applications
ESA-22806

Group 10

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1. Introduction

1.1. Problem Description

Millions of plastic cups and paper cups are used in the Netherlands each day. Just at the Wageningen University alone, 2,5 million cups, mainly made of plastic are used and thrown away every year (Green Office Wageningen, 2018). The increasing consumption of hot beverages and the trend of coffee-to-go has an immense impact on the environment. The plastic consumption has increased enormously in the past half-century worldwide and is expected to increase in the future (Sheppard, Gilman, Neufeld & Stassen, 2016). The public's attention to the problem of plastic pollution has encouraged consumers of hot beverages to use reusable cups such as the KeepCup. The reusable cups have become part of the modern lifestyle and a favourite among consumers sensitive to this issue (Gabbatiss, 2018). The discussion whether using a disposable or reusable cup is better for the environment, has therefore become an important and widespread subject of study in the past decade (Ligthart & Ansems, 2017).

Even though generally plastic cups are considered as the main problem of environmental pollution, paper cups have a negative impact on the environment as well. Many cups are made of paper with an inside layer of polyethylene plastic which means they are difficult to recycle. Paper cups that are downed and disposed of are made from virgin paper material. That means, valuable forest areas are degraded to produce a product with a lifespan that is only as long as it takes to drink a coffee. Since they are disposed after a single use, the environmental footprint of manufacturing, distribution and disposal of these cups have a major impact on climate change, one of the main environmental challenges of our time (Gabbatiss, 2018). If modern economy continued to provide plastic products at low cost and created a market where the disposal of cups is more economically attractive than recycling, then the change to a more sustainable global production with lower environmental impacts is inconceivable (Sheppard, Gilman, Neufeld, Stassen, 2016). Hence, there is a growing consensus that global environmental impacts of production as well as recycling costs of products should be reduced to reach a more sustainable society. Changing societal patterns of production and consumption is hereby a crucial step in the process.

This is why, the Wageningen University & Research and the Green Office Wageningen have established the use of reusable cups on the campus in order to reduce environmental impacts. With the start of the *Reuse Revolution* campaign in 2017, the reusable product 'KeepCup' has been brought to the university as an alternative to the single-use cups. Since then, plastic and paper waste has been reduced by enhancing the use of re-usable hot beverage cups on university premises (Kleis, 2017). This is done by promoting the KeepCup to consumers at the cafeterias, instead of a paper or plastic cup, and giving discounts when this (or a different) reusable cup is used. Many comparative Life Cycle Assessments focusing on the impacts of carbon emissions have already been undertaken of the individual beverage cups (Ligthart & Ansems, 2017). Although it is widely believed that the life cycle of KeepCups is more sustainable than paper cups or plastic cups, the analysis among multiple aspect was never analysed properly in the university and the environmental performance of these cups is still discussed. As the commissioner of this project, the Green Office requested us to investigate which one of the cups is more sustainable at Wageningen University. This research paper therefore helps to quantify and identify the current state and impacts on university premises and how these are changing with time in order to find answers to the question whether reusable cups or single-use cups are more sustainable.

1.2. Research Objectives

The external research objective is to help establish a more sustainable behaviour in terms of consumption within the distribution chain of Wageningen University. The internal objective of this research is *to help identify the most preferable alternative between KeepCups and paper cups to the single-use plastic cups, to support the Green Office in decision-making of which cup should be*

promoted within their campaign. This will be done by applying the method of the Multi Criteria Analysis (MCA) that will *help to identify and quantify the main environmental impacts through different criteria of the manufacturing, use and disposal of the cups* as well as by the Stakeholder Analysis that will *help to identify interactions between stakeholders.* In order to sufficiently answer this objective, several specific research questions will guide the research.

1. What are the *Drivers, Pressures, States, Impacts, and Responses* to the use of a plastic single-use cup?
2. What are the stakeholders impacting in this research and how are they affected by the different options of drinking systems (plastic cup, paper cup, KeepCup) for hot beverages at Wageningen University?
3. What is the most favourable option of drinking system, assessed by different criteria in a Multi Criteria Analysis?
4. What implications result from the findings of the DPSIR, Stakeholder Analysis and the Multi Criteria Analysis?

The results aim at providing well-founded and transparent recommendations to support claims made within the Reuse Revolution campaign of the Green Office. With the successful implementation and communication of the results, students and employees should be made aware of using the most sustainable cup when consuming hot beverages in cafeterias on the campus. The University of Wageningen will also benefit from the results in ways of maintaining and improving their reputation as a sustainable university (WUR, 2018).

1.3. Delineation of the Research Subject

Current challenges like climate change, resource depletion and waste are the reason why the circular economy model – which aims to minimize resource use in the production process and reduce negative environmental and social impacts – is the background of this study. The study focusses on the typical stages manufacturing, use and end-of-life of the three products, thus also following life cycle thinking. The products are the plastic cup as a benchmark, and the two alternatives; the paper cup and KeepCup, which are provided by caterers on campus. The Green Office intends to investigate which one of the cups is the more sustainable option. The methodologies of MCA and Stakeholder Analysis will help to reach the goals of the circular economy and make sure this vision results in concrete benefits for the university. The MCA can complement this vision to end the disposable society on campus with robust measurements, helping to ensure feasibility of implementation at the product level.

The project specifically focuses on the Café The Spot in Orion that is responsible for, and influenced by, the changes taking place as plastic cups are being replaced by paper cups or KeepCups. The discussion of reusable and disposable cups has already been raised before on campus, but their sustainability has never been clarified in a concrete way. The time frame of our research project is limited to one year, as the Green Office intends to launch a campaign of a one-year term, prospectively starting in 2019, that aims to create more sustainable behaviour on the campus by supporting the usage of sustainable alternatives to single-use cups. Therefore, it is important that by the end of December 2018 the results of this report are available in order to help the Green Office evaluating and revising plans to eventually adapt their Reuse Revolution campaigns and strategies for successful implementation.

1.4. Target Audience

The target audience for this study involve the Green Office Wageningen (GOW), S&I (Sustainability and Internationalization), Wageningen University & Research (WUR), OSP Catering at The Spot, as well as the students and employers that consume hot beverages. In this report the target audience are at the

same time the stakeholders, which will be part of the Stakeholder Analysis. A key objective is to present and communicate the study and results with to stakeholders on distinct levels of (i) practical and plainly explained for use in external communications, sales and marketing and (ii) reliable and transparent in terms of method, data and interpretation.

1.5. Approach to the Study

The research study undertakes a comparative study of the environmental impacts of the three cup options using the tools of the Multi Criteria Analysis and the Stakeholder Analysis. These will form the framework of the project for identifying and quantifying the various impact criteria.

Steps of this study

- Establish the methods and data for the development of MCA and Stakeholder Analysis
- Identify key environmental impacts of each of the three cups (plastic cup, paper cup, KeepCup) in the university
- Provide a critical assessment of the environmental performance of each product
- Benchmark plastic cup against KeepCup and paper cup under selected criteria
- Identify opportunities for improvement and recommendations to minimise environmental impacts.

1.6. DPSIR Framework

The European Environmental Agency (EEA) has developed the *Driver-Pressure-State-Impact-Response* (DPSIR) framework to analyse and assess the relationships between aspects of environmental problems and factors in society. According to the DPSIR framework, the developments of economical and societal factors are the *Driving Forces* (D) which have a negative *Pressure* (P) on the environment, leading to an environmental change of the present *State* (S). This results in Impacts (I) on human health, ecosystems and functions of society, which create societal *Responses* (R). The *Responses* affect in turn *Driving Forces, Pressures, State, Impacts* through a variety of limitations and adaptations actions (Maxim, Spangenberg, O'Connor, 2009). The application of the DPSIR regarding the sustainability aspects for the usage of plastic cups in Wageningen campus, helps to identify and to assess the rise of environmental problems, their societal implications and potential responses. Changes in the environmental performance within the context of Wageningen University will then be communicated through appropriate indicators. The indicators are used to assess the environmental impacts on climate change mitigation and impacts of plastic pollution and to analyse the production and resource extraction of plastic cups.

The *Drivers* in the framework of the usage of plastic cups are the increasing demand and consumption of hot beverages in single-use plastic cups deriving from an increasing number of consumers at Wageningen University. In this research consumers are students and employees on the campus. The number of students in Wageningen University has been increasing the last sixteen years. This is shown via the rise of registration numbers of students of around 4500 in 2002 to up to 12 000 students in 2018 (WUR, 2017). Therefore, the demand for hot beverages and coffees have been rising (Gabbatiss, 2018). It is also a widespread and popular consumer behaviour on the campus to drink coffee or tea out of plastic cups. This is a global trend of the 'modern lifestyle' which is driven by the cultural change within the Western world and the reason why especially young people tend to consume hot beverages in a single-use plastic cup rather than in reusable cups (Lee, 2015). The plastic cups are made of polystyrene (PS) and used just for the time drinking the coffee or tea and are then thrown away. This means, that the overall production of plastic cups and polystyrene material has increased according to the rise in demand.

The virgin disposable plastic cups are made from crude oil and natural gas. The types of polystyrene that are used for plastic cups are General Purposes PS (GPPS), High Impacts PS and titanium oxide

(Ligthart & Ansems, 2007; Van der Harst-Wintraecken, 2014). The *Pressures* that will arise are the extraction of crude oil and water for the creation of virgin polystyrene, as a result of production of plastic cups. Another pressure is the increasing amount of waste that is produced within the university. Plastic cups of the university are currently not recycled recycling because of the deterioration of the quality of polystyrene, leading to a cradle to grave product system. As a result, the waste of the plastic cups ends up in the incineration process. The *Pressures* throughout these lifecycle phases of plastic cups – raw material acquisition, material manufacture and production, transportation, distribution and incineration – are the emissions of carbon dioxide and other greenhouse gases (GHG) which are produced and released to the atmosphere. The waste management and disposal results in possible emissions of macro- and micro plastic particles which enter soil layers and finally end up in the world's oceans (Britannica, 2018; Jariwala & Parmar).

The supply of plastic cups on the campus causes an increasing production and accumulation of plastic waste. Increasing plastic cup usage implies also environmental changes of the *State* arising from exploitation of raw materials and natural resources which result in reduced availability of finite resources and fresh water resources. The emission and exposure of plastic particles change the State in means of decreased soil quality and water quality of marine and fresh waters. Through the GHG concentration in the atmosphere the global climate state is changing through deterioration of air quality, especially through carbon dioxide emissions arising from manufacturing processes, transportation and incineration of single-use plastics.

The environmental changes result in adverse *Impacts* on climate change through the GHG emissions that contribute as multiplier of global warming. The emissions are a result of the energy consumption in plastic manufacturing and combustion of polystyrene (NRCAN, 2018). The air and plastic pollution can cause health problems, especially for residents living directly at industrial sites. The US Environmental Protection Agency (EPA) identified chemical by-products that were released into the air through its manufacturing process which have also health effects (The EPA blog, 2009). The styrene component of PS is also seen as a probable human carcinogen, however, as long as polystyrene only contains a low level of styrene it is considered as safe (Access science, 2018). Negative Impacts of the plastic pollution and land conversion through extraction on industrial sites are causing damage to marine and terrestrial environment. As a consequence of habitat loss and ingestion of nano- and macro plastics in marine and terrestrial biota are the degradation of biodiversity and ecosystem services (occurrence of species). Societal *Impacts* on the Wageningen University emerge in terms of negative reputation and perception as plastic cups are still in use on the campus.

The *Responses* to decrease the amount of plastic cups consumption in the university feedback to each of the elements of the DPSIR framework and should report recommendations and measures to the university. Main response should be the reduction or replacement of plastic cups and the increasing implementation of more sustainable alternatives, which can be subsidized by the University itself. Management actions on campus such as regulations on consumption of single-use and reusable cups (price regulations and discounts) are already implemented and create improved conditions on consumption behaviour. It is important to improve the information exchange about environmental impacts of plastic cups and communication to the students and the Green Office, regarding the issue why the 'better' cups should be used instead of the 'bad' plastic cup. Awareness campaigns to reduce and reuse plastic cups are therefore important *Responses* to encourage students and employees to change their current behaviour towards a more sustainable one. A schematic overview of the DPSIR for this study can be viewed in the Annex 1.

2. Methodology

2.1. Stakeholder Analysis

Due to the nature of this report it is important to identify and investigate who the persons and or groups are that are interested and or affected by the research (Durham, Baker, Smith, Moore & Morgan, 2014). The identification of those persons and groups, or rather stakeholders, is seen as an important discipline for planning strategy and 'making decisions' as it helps to understand the relevance and interest of stakeholders with regard to a specific problem (Chapleo & Simms, 2010). Therefore, a successful engagement with stakeholders, results in an improved utility of the research as it provides access to additional resources or information. In addition, stakeholders can benefit from engaging with researchers as new knowledge, that can be used in the scope of a project, will be generated (Durham et al., 2014).

There are several approaches to proceed with a stakeholder analysis. Within the scope of this report four approaches will be applied. First of all, the main stakeholders need to be identified; who they are and what they do. Secondly, the underlying hierarchy of and relations between stakeholders will be explored. This will help to more precisely pursue with the third step of the analysis: An influence-interest matrix will clarify, to which extent the respective groups have a stake and opinion regarding the issue of sustainability of cups for hot beverages. It is important to consider that not all stakeholders have the same motivations and interests, which is why the level of engagement can vary for different stakeholders (Durham et al., 2014). Each stakeholder will have a different opinion on aspects of sustainability. Analysing the influence and interest will help to assess the research-internal relevance of stakeholders' opinion in terms of determining the weights of sustainability-criteria used to carry out the multi-criteria analysis. Lastly, the previous steps will allow to determine the participation of stakeholders within the scope of this research. This will give the research team an overview on when and why the designated stakeholders should be included in different stages of evaluation

The identification of stakeholders will be based on information given on platforms of the respective stakeholder as well as opinion pieces of third parties. The hierarchy of and relations between stakeholders as well as their role in terms of interest and influence will be assessed through semi-structured interviews with the GOW and S&I and written communication with OSP Catering. The approach for deductions within 'Stakeholder Participation' will be derived from Buronshaw & Wang (2014).

2.2. Multi-Criteria Analysis

In this paper, the Multi Criteria Analysis (MCA) was chosen to be the framework to assist in delivering results to the GOW. The MCA offers a good method that allows a focus on some aspects of a case that are essential to a specific issue (Dodgson, Spackman, Pearman, & Phillips, 2009). Measuring solely the relevant details pertaining to a case increases the efficiency and effectiveness of a project.

The MCA is an internationally standardized instrument that facilitates the decision-making process to a complex problem involving multiple criteria or objectives. It is used to help identify and decide between different alternatives based on the relative significance of their criteria and to finally compare the alternatives in order to support the final decision (Mateo, 2012). In this project, the alternatives to the plastic cup are the KeepCup and the disposable paper cup at Café The Spot. This analysis will measure the sustainability of the respective cups based on the values of the GOW. Due to the subjectivity of the relative importance of the different criteria, the Analytical Hierarchy Process (AHP), originally developed by Saaty (1987), is chosen as the specific MCA method for this paper and adapted in favour of this research. Measurements from both physical and psychological events can be included in the

weightings, making it possible for subjectivity and objectivity to co-exist in the same framework (Saaty, 1987).

In order to use the AHP model a problem has to be hierarchic. The problem has to be derived from a general societal problem, descending to the overall objective. The overall objective (focus) can be compartmentalized in criteria, which in their place can be divided in to sub-criteria (Saaty, 1987). The GOW established priorities for their main criteria by judging them in pairs in matrixes similar to the one in Table 1. They assigned weights to the different criteria based on a series of questions related to the relative importance of the criteria. This was by filling in matrixes with scores from the scale in Table 2.

Example: *How important is criterion A relative to criterion B?*

Afterwards, the weightings are normalized and placed in order of importance to get an overview of the average weight for each criterion.

The steps of the normalization process

1. Add values of each column
2. Divide each cell by the total sum of the column

This number then provides outcomes for the normalized matrix of the criteria. In the next step, the final priorities are determined by adding the values of each row. In this way the highest priority criteria relative to the other criteria is calculated.

In the next step, the results acquired from the criteria data, were evaluated and interpreted. Ratings were assigned from the scale used in by translating the values from the respective criteria. For instance, the GHG emissions from a KeepCup vs. a Paper Cup vs a Plastic Cup are all converted to the same functional unit. These values are then placed in increasing order to afterwards translate them to the intensity of severity scale from 1 to 9. The lowest severity of the 3 cups is equal to 1 and the highest severity is a 9. After weighting the matrixes, they should be normalized in the same way as the previous weighted matrixes with the GOW. Finally, the overall preference score is calculated by summing all weighted average scores on each criterion.

Table 1: Example Matrix with criteria

Matrix 1: Criteria	**A**	**B**
A		
B		

Table 2: Scales indicating the intensity of severity (adapted from Saaty, 1987)

INTENSITY OF SEVERITY	DEFINITION	EXPLANATION
1	Equally severe	Two activities contribute equally to the objective
3	Moderate severity of one over another	Experience and judgment strongly favor one cup over another
5	Essential or strong severity	Experience and judgment strongly favor one cup over another
7	Very strong severity	A cup is strongly favored, and its dominance demonstrated in practice
9	Extreme severity	The evidence favoring one cup over another is of the highest possible order of affirmation

2.2.2. Cups

The following section explains the assumptions made the different cups are explained here. The materials used for manufacturing the original KeepCup are polypropylene for the cup itself, silicone for its band, polyethylene for the plug and band and (KeepCup, 2018). The assessed cup in this report is “KeepCup The Original” and its volume is 340 ml. The materials used for the paper cup are paperboard with polyethylene lining and its volume is 180 ml. And finally, for the weight of the plastic polystyrene cup (PS) 4.0 grams is used, since the weight ranges between 3.8 and 4.5 grams (Ligthart & Ansemsm, 2007). Next to this, the PS cup of 180 ml is used for comparisons.

2.2.3 Origin of data

For this study both qualitative and quantitative data is used. The quantitative data gathered for the MCA primarily came from different reports on conducted LCA. For the qualitative data, a survey was drafted to test the perception of sustainability for the three different cups, this can be found in the Appendix. The survey consists of 12 questions to test the attitude of people towards the perceived sustainability of the cups. The questions could be answered with a Likert scale, and reverse questions were also added to check the observations. The Likert scale was applied in order to make the results applicable in the MCA analysis. Furthermore, meetings with the GOW also provided insights in to the weightings assigned for the different criteria.

3. Results

3.1. Results for Stakeholder Analysis

This section presents the results of the stakeholder analysis. First, the main actors having a stake in this research and thus the campaign are identified. The stakeholders covered are: The Green Office Wageningen (GOW), the student party S&I (Sustainability and Internationalization), Wageningen University and Research (WUR), OSP Catering, as well as students and staff of WUR. Secondly, the hierarchy of stakeholders will be explored. Thirdly, an interest-influence matrix will be presented, and finally, the participation of stakeholders within this report will be determined.

3.1.1. Identifying stakeholders

The Green Office

In October 2012, the Green Office was launched at WUR as the second organization of this kind, which is run by students, within the Netherlands (WUR, a, n.d.). The general aim of the Green Office Wageningen (GOW) is to not only give students and employees an access to sustainable alternatives in their workplace. They also work on creating strategies to promote an actual behavioural change as well as collaboration on issues regarding sustainability (The Green Office, n.d.). To help make the mind-set and practice on campus more sustainable in terms of waste reduction, the *Reuse Revolution*, initiated by German PhD candidate Lilo Trogisch, has brought the KeepCup to WUR in November 2017 (Kleis, 2017). The goal of this project was to "reduce the number of disposables used at the canteens and in the coffee machines" (The Green Office, a, 2017). In its first year, the academic year of 2017/2018, the initiators of the *Reuse Revolution* acted independent from the GOW and implemented the idea to integrate the KeepCup in the main body of the university through the caterers in WUR's education buildings (Forum, Orion, De Leeuwenborch) (Van Daele, 2018). For the academic year of 2018/2019, the GOW decided to pick up the idea of the *Reuse Revolution* and start a campaign with the aim to raise awareness on the amount of waste produced on campus through the extensive consumption of single-use cups (The Green Office, a, 2018).

Sustainability and Internationalisation (S&I)

The S&I is one of the parties of the Student Council (SC) of WUR. The SC is consisting of twelve members and representing interests of students at WUR. S&I in specific was created by students that were concerned about sustainability issues at WUR. It is their general aim to increase the environmental awareness at WUR by supporting and promoting projects that target sustainability. For this, the S&I stays in contact with other sustainable organizations at WUR (WUR, e, n.d.; WUR, f, n.d.). The idea of S&I to participate in the coming Reuse Campaign became manifested in the GOW's 'Get Together' in November 2018. Many students expressed their concerns about plastic consumption on campus and were the driving force to put this issue on the agenda of the GOW. For this reason, and since the S&I acts as the voice of students, the chair of S&I, Joshua Wambugu, made the suggestion to support the campaign through communication with the Executive Board. Further contributions of the S&I within the campaign is still to be determined as it is dependent on the main objectives of campaigning, which are going to be discussed in the coming meetings (The Green Office, b, 2018).

Wageningen University and Research - Executive Board

Wageningen University and Research (WUR) is very well known for its leading level in terms of sustainability in education, research and operational management (Chiodo, 2013). With its mission "[…] to improve the quality of life", WUR aims to set an example of sustainability. As a consequence, the campus of WUR is said to be on the forefront on the field of 'sustainable knowledge centers within the Netherlands (WUR, b, n.d.). Every year, WUR participates in the GreenMetric ranking of University Indonesia which is based on six different criteria; setting & infrastructure, energy & climate, waste, water transportation and education & research. Having achieved the 26th place of the ranking in 2014, WUR made its way to the 1st place on a global scale in 2017. In that year, WUR reached the most points in

the category ‘waste’, followed by ‘energy & climate’. (WUR, c, n.d.; University Indonesia, 2017). This illustrates that Wageningen as institution is continually concerned to improve its practices regarding sustainability. In the scope of this research, the Executive Board (EB) is considered to be the stakeholder that embodies WUR as institution. The EB is advised by the Supervisory Board, which supervises management and governance well as general state affairs of WUR. The Supervisory Board is, however, not included as stakeholder within this report (WUR, d, n.d.).

OSP Catering (The Spot, Orion)

OSP Catering is the caterer that is present in the canteen of Orion building on campus of Wageningen University. For the scope of this report it was determined that including the views and interest of all caterers present on campus would not be feasible. OSP Catering does business according to their general strategy: *“We don’t want to be the biggest, but we want to be the best and greenest service provider in the Netherlands [by contributing] positively to the environment and to society”* (OSP Catering, a, n.d.). In the Spot, OSP Catering exploits its business strategy with quite an inclusive approach with regard to students and valuing their input for issues surrounding sustainability issues in the area of food. The caterer itself is certified with the ISO 14001 certificate (OSP Catering, b, n.d.), meaning that it is certified for its environmental management system, and that it works according the ‘plan-do-check-act' cycle. Therefore, their focus is put on continuous improvement of performances and the protection of the environment, as well as regulation of environmental risks as a result of the activities within the organisation. Furthermore, the organisation needs to comply with relevant applicable laws (SSCM, n.d.).

Students and Staff WUR

Students and staff make up the largest group of the consumers of hot beverages at WUR. Their perception of the three options that are studied in this report is highly relevant since implementing of changes affects the students and staff directly. Sustainability issues are high on the agenda in curriculums that are taught at WUR. Hence, awareness surrounding topics in relevant fields is high among students and staff. Agency of students and staff is, perhaps, limited on an individual level, however at WUR there are a variety of student organisations that voice green-minded opinions and focus on sustainability issues in Wageningen. These organisations work together in the Green Active Network (GAN), which functions as “a platform for all green-minded organisations and initiatives in Wageningen” (GAN – Green Active Network Wageningen, n.d.). In the academic year of 2017/2018, there were 12,001 students enrolled at WUR from 103 different nationalities (WUR, g, 2017). On top of that, 4,887 people were employed at WUR (WUR, h., 2017).

3.1.2. Hierarchy and Relations

This section is dedicated to exploring and understanding the hierarchy of and relations between stakeholders. Figure 1 shows a simplified structure (only including main stakeholders) of relations within the university. It suggests a bottom-up hierarchy with students having the possibility to give their interest in sustainability voice through green-minded organisations and initiatives. To some extent, these organisations can act independently but are still regulated by the EB of WUR, which is indicated through the dashed line underneath ‘Executive Board WUR’.

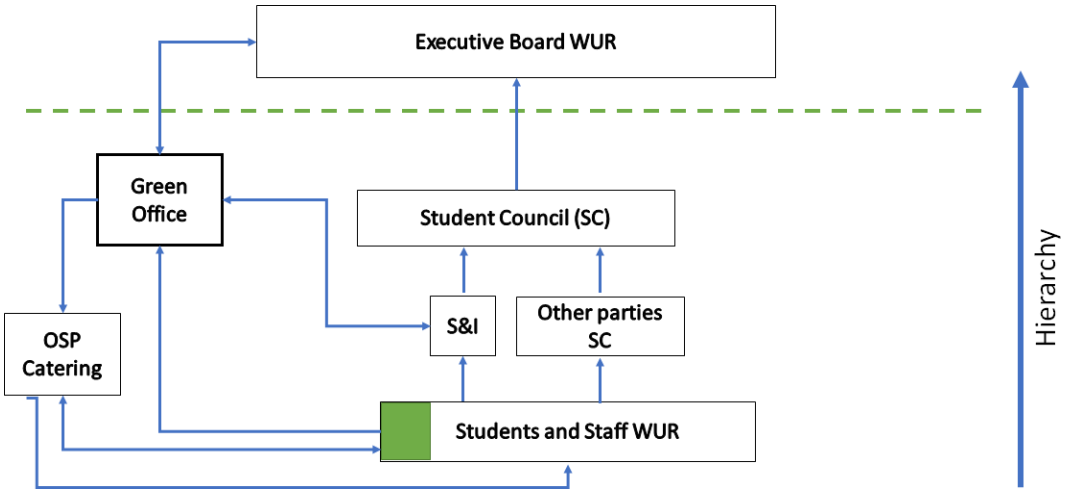

Figure 1*:* Hierarchy of identified stakeholders, while indicating relationships between stakeholders. The green section in 'Students and Staff WUR' represents green-minded students that proactively engage in sustainability issues through for example volunteering for the Green Office or providing feedback to the caterers regarding sustainability. The dashed line between 'Executive Board WUR' and the 'Student Council (SC)' and the 'Green Office' indicates that in terms of power the 'Executive Board WUR' has the final say when it comes to decision-making.

WUR and GOW – The GOW reinforces sustainability strategies and provides a platform for exchange of information (The Green Office, 2016). It is for this reason that WUR as institution values the critical attitude of the GOW about sustainability. As this critique helps the university to keep a sharp focus on its sustainable orientation (WUR, b, n.d.), the GOW can act quite independent when it comes to design and implementation of the campaign. However, the GOW is still policed by the EB which is the stakeholder that has power over the approval of budget for facility services. However, when it comes to implementations of 'green ideas' that call for revision of contracts with external stakeholders (e.g. providers of plastic cups for vending machines), the GOW is dependent on the voice of S&I (The Green Office, b, 2018).

S&I and WUR – S&I as one party of the Student Council (SC) has four major rights: The right to (dis)approve plans of the EB, to advice the EB, to propose initiatives to the EB, and to obtain information (WUR, f, n.d.). Six times a year, the SC sits together with the EB in a Consultation Meeting in which the introduction of an initiative (called 'Memo') can be discussed. In the case of an agreement on this Memo, the SC has the permission to implement its idea (S&I, 2018).

S&I and GOW – The right of S&I to propose initiatives to the EB drives them to tie up with other green-minded organisations, like the GOW. The GOW is respected for their ideas, independent momentum and power to make a change (S&I, 2018). Therefore, S&I has offered its support to the GOW regarding communication with the EB (The Green Office, b, 2018).

GOW, S&I and Students, Staff – Both the GOW and S&I are a representative body for green-minded students – GOW through voluntary action by students, S&I through votes from students. They facilitate the realization of ideas and support projects regarding sustainability (The Green Office, 2016); as for the following campaign is an example: it was students that eventually put the fight against waste high on the recent agenda (The Green Office, b, 2018). This direction of momentum can be taken as an example for a bottom-up hierarchy.

GOW and OSP Catering – As for now, the GOW has not determined yet to which extent the caterers could contribute within the scope of the campaign. Regarding the implementation it is rather the GOW

that communicates with the caterers than it is WUR. Although caterers like OSP Catering have their contracts, they still have the power to make their own decisions (e.g. on which cup they want to sell their hot beverages in), as long as these are in line with their contracts (The Green Office, b, 2018).

OPS Catering and Students/Staff – Green-minded students are represented by the GOW and S&I. Hence, they have an indirect influence in deciding which kind of cup should be predominant at WUR. However, we should not forget that there are students, that have a neutral or even an opposite interest regarding the goals of the campaign. If OSP Catering, and other catering services, make their business decisions dependent on the recommendations of the GOW and S&I, those students are exposed to the effects of decision-making with regard to the choice of cups for their hot beverage. This is indicated in Figure 1 through the arrow from OPS Catering feeding back into the non-green-coloured part of 'Students and Staff WUR'.

3.1.3. Interest and Influence

Having identified all relevant stakeholders for the scope of this research, as well as their relations, one should keep in mind that the level of engagement is different for every stakeholder. Depending on their influence or power and interest, the level of interaction may differ in relevance or even feasibility. Figure 2**,** gives an overview of the degree of the interest and influence of the respective stakeholders. The matrix is divided into four boxes, each of which represent a different level of engagement; with the highest level being 'collaborate', the middle levels being 'involve' and 'consult', and the lowest level being 'inform' (Durham *et al*., 2014).

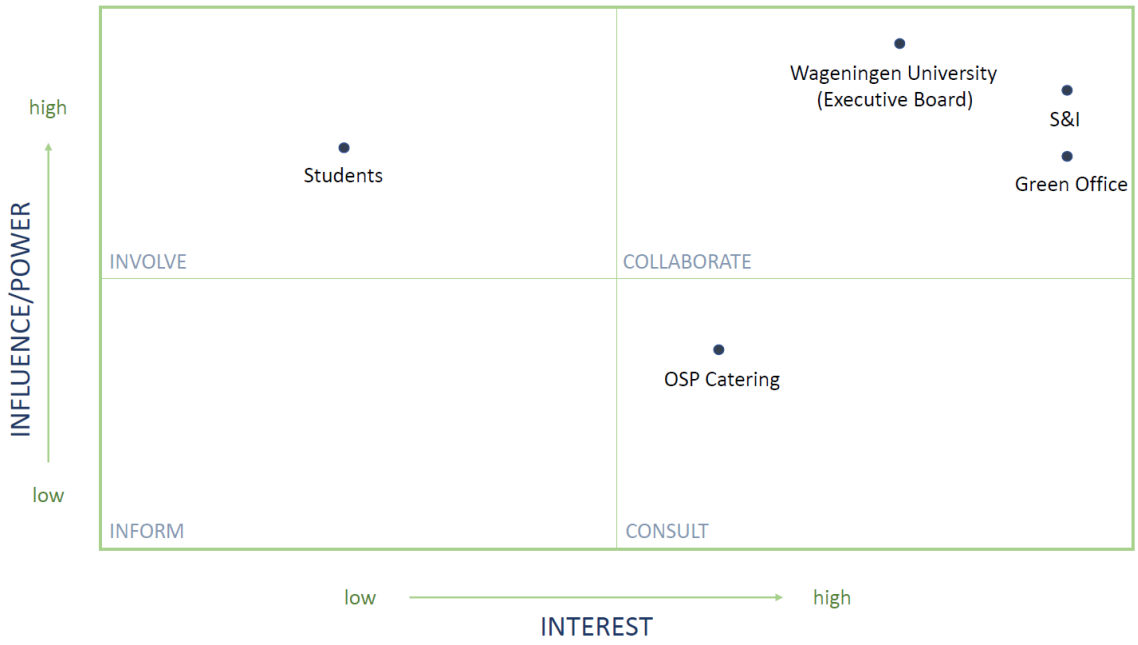

Figure 2: Interest-influence matrix of relevant stakeholders

Collaborate

S&I and the Green Office (GOW) are the stakeholders the most interested in affected by different aspects of both the results of this research and the campaign. The GOW strive to reduce the number of disposable cups for hot beverages at WUR. For the past year, they have been promoting the KeepCup as a more sustainable alternative for disposable cups, although they cannot support their recommendations with facts. Therefore, it is in their interest to base the following campaign on a body

of knowledge. Within the campaign it is their objective to reduce waste on campus (The Green Office, a, 2018); at this point, it is important to consider that the definition of sustainability (of cups) is highly dependent on the weights assigned to the multiple criteria (energy consumption, water use, waste, GHG emission, perception of use; further explained in 3.2.) of sustainability. Consequently, the GOW is affected by the outcomes of the research (i.e. the MCA), as they would need to adjust their strategies to be in line with their commitments towards sustainability. The flow of information between the GOW as commissioner and the research team of this report is high. Thus, collaboration with this stakeholder is essential.

For the S&I, raising environmental awareness on campus stands high. As for the GOW, it is their aim to reduce waste on campus. On a long term, they strive towards a university in which students bring their own cup – without forcing them but rather by stimulating their consumption attitude and ultimately accompanying them towards behavioural change. It is S&I's vision of the campaign to reduce the usage of disposable cups consumed by students and staff in a day in WUR's education buildings. It should be considered that their strategy for the campaign is not only affected by the results of this research. Since they have a different connection with the EB, S&I needs to provide more statistics on the usage of disposable cups for the purposes of the Consultation Meeting (S&I, 2018). It should also be mentioned, that S&I as one party of the SC represent the interests of students, especially when it comes to sustainability. Thus, their commitment to students' requests may as well affect the results of the next SC election.

Having the power to define and determine the problem, the influence of the GOW for the campaign is high. They have a free play when it comes to design and implementation of the campaign, as long as both are in line with the guidelines of WUR. However, given the hierarchy within the university (see 3.1.2.), the power of S&I is higher than that of the GOW.

It is WUR's ambition to be a 'socially responsible organisation'. Thus, they aspire to integrate sustainability into activities within research, education and operational management as much as possible (The Green Office, b, 2017). Since it is in WUR'S interest to uphold its green image, finding and promoting the most preferable cup can be useful for implementing operational policies. The university's interest is not as high as the interest of the GOW and S&I because it is not actively participating in setting up the campaign. However, WUR will be affected by the outcomes of both research and campaign. If the KeepCups turn out to be the more favourable alternative, WUR might need to subsidize caterers to sell a higher amount of KeepCups. At this point it is important to mention that it is not understood to which extent caterers are subsidized by the university to sell KeepCups at a lowered price. WUR does not directly influence the design and implementation of the campaign. However, the EB has the final power in decision-making, especially when the campaign affects existing contracts with external stakeholders, but also when it comes to granting budgets for campaign related activities. The EB as stakeholder with the highest power needs to be fully engaged in the project.

Involve

Green-minded students and staff at WUR are interested in the campaign as it is in line with their raising concern with regard to waste and sustainability issues on campus. However, there are students on campus that are not aware of the issue or not interested in promoting change. They are exposed and affected by the measures taken by other stakeholders. This is why their interest is rather moderate. On one hand, direct influence of students and staff on the implementation of the campaign is relatively low. On the other hand, students have the power to put the issue of single-use cups high on the agenda through organisations like the GOW and S&I. Participation in those kinds of networks provides several routes of influencing the outcomes of this campaign and therefore the options for cups for all students. For this reason, it is important to involve students from the very beginning this project. Furthermore, students and staff hold the power of consumers as 'collective'. Collective action is essential here since this enables the proliferation of individual agency (Cleaver, 2007). This means, that they have economic power since they are directly responsible for the demand of coffee and specific cups.

Consult

The interest of OSP Catering in the campaign is high as the company aspires to be a green service provider that supplies with respect to the demands of consumers on campus. According to the manager of The Spot, 2500 paper cups are used on average on a weekly basis. Looking at this statistic, the interest of OSP Catering became even more manifested: the manager of OSP Catering aims to reduce the amount of paper cups leaving their counter (Joosten, 2018). As a consequence, this stakeholder needs to be provided with information as well as interaction regarding the campaign. Since the manager's schedule is busy it is important to not overwhelm this stakeholder with too much or irrelevant information (Durham *et al.*, 2014). Caterers can decide themselves to which extent they want to be affected by the outcomes of the campaign. As one of the leading caterers on campus, OSP Catering has the potential to influence the actions of other canteens. I monthly meetings, all catering services come together and talk about recent issues in which OSP Catering may make an example out of a reduced usage of disposable cups. However, it is assumed that profitability will still be a leading factor in deciding on what product is sold.

3.1.4. Stakeholder Participation

On basis of the previous findings, the participation of stakeholders can be assessed (Table 3). As commissioner of this report, the GOW will have the say in deciding on the research objective and, as a consequence, in deciding on the weight of MCA-criteria. WUR/EB and S&I as well as Students and Staff will have an indirect influence in the research objective as those actors are all, to their individual extent, interested in the sustainability of cups for hot beverages. The findings of this research will be directly reported to both the GOW and S&I since they play the key role in design and implementation of the campaign. Due to time constraints, a direct engagement with WUR/EB through the research team will not be conducted. The communication with WUR/EB will be mainly carried out through S&I. OSP Catering will receive recommendations through the GOW as well as the research team. Through the execution of the campaign, Students and Staff of WUR will eventually get an insight in the outcomes of this research.

Table 3: Stakeholder participation during research

Stakeholder	**Deciding on research objective**	**Deciding on the weight of MCA-criteria**	**Communicating and reporting on findings**
WUR Executive Board	+	-	++
Green Office Wageningen	+++	+++	+++
S&I	+	-	+++
OSP Catering	-	-	++
Students and Staff	+	-	+

- little/no participation

+ some participation

++ moderate participation

+++ high level of participation (decision-making, a.o.)

3.2. Results for Multi-Criteria Analysis

In this chapter, results of the MCA analysis will be presented. Firstly, the criteria and sub-criteria which resulted from the first interview with the GOW are shown. Secondly, results of the survey will be discussed, which provide data for the criteria '*Perception of use'.* The qualitative results from the other criteria are presented in the succeeding section. Finally, weights are assigned to the corresponding criteria based on the preferences of the GOW and the gathered data.

As mentioned in the methodology, in order to conduct a proper AHP model, a problem has to be hierarchic. The problem has to be derived from a general societal problem, descending to the overall objective. The overall objective (focus) can be compartmentalized in criteria, which in their place can be divided in to sub-criteria. A schematic overview of the focus, criteria and sub-criteria is given in Figure 3 and illustrates the hierarchy in this project. The general focus is the sustainable usage of cups on Campus. The focus can be subdivided into Environmental Factors and Social Factors. Together with the GOW it was agreed up on that the criteria and sub-criteria depicted matter the most. This led to the sub-criteria: Energy Consumption, Water Use, Waste, GHG Emissions and Perception of use. In table 4, an overview of the operationalisation of each of these criteria is given together with their respective units.

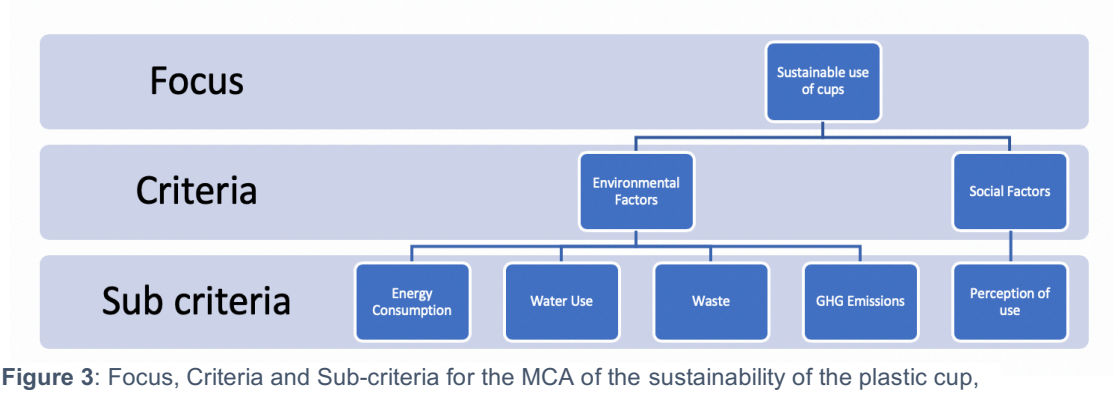

Figure 3: Focus, Criteria and Sub-criteria for the MCA of the sustainability of the plastic cup, paper cup and KeepCup after consulting the Green Office of Wageningen

Table 4: The criteria used for this MCA and their units and operationalisation explanation Wageningen University and Research.

Criteria	Unit	Operationalisation
Perception of use	Quantitative – based on a Likert scale (1 to 5)	How do the different stakeholders perceive different cups in use
GHG emissions	CO_2-eq	What are the GHG emissions per cup: paper / reusable cup for their production, use and dispose phases
Energy consumption	kWh	What is the energy consumption per cup paper / reusable cup for their production, use and dispose phase
Water use	L	What is the water use per cup paper / reusable cup for their production, use and dispose phase
Waste	kg	What is the waste in terms of kg per material wasted, per cup: paper / KeepCup, for their production, use and dispose phase

3.2.1. Results qualitative data

In order to assess the criteria *Perception of use*, a survey was drafted, and the results were converted to a Likert scale in order to make it applicable in the MCA. In the survey, the perceptions of 193 students and coffee consumers on campus towards experiences in usage of different cups used at Wageningen University were measured on the basis of a Likert scale (1. Strongly disagree; 2. Disagree; 3. Neither agree nor disagree; 4. Agree; 5. Strongly agree). It became apparent that the general perception towards the experience of plastic cups was negative (Plastic, Negative experience – 3,93) and as least sustainable (KeepCup, Sustainability perception – 1,75). The experience of the KeepCup was perceived as positive (KeepCup, Positive experience – 3,94) as well as experienced as sustainable (KeepCup, Sustainability perception – 4,18). In the case of the paper cup, students were uncertain about how they perceived using the paper cup. The notion was that on average students did not agree nor disagree with regard to perceiving using a cup as positive or negative (Paper, Neither positive nor negative experience - 2,68; Paper, Positive experience – 3,07; Paper, Negative experience – 2,92). This result also came forward based on the questions about sustainability of the paper cup, again, students did not agree nor disagree about whether the paper cup was sustainable (Paper, Sustainability perception – 2,61).

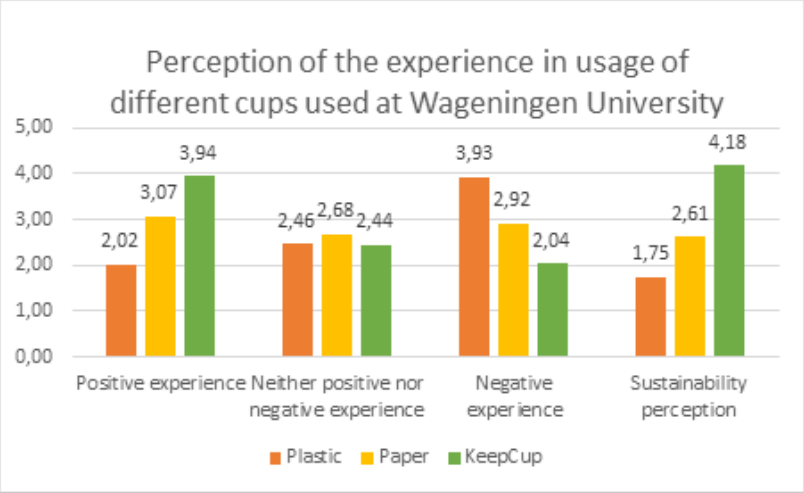

Figure 4: Results of survey. X-axis reflects the different experiences of usage. Y-axis is the average perception of these experiences

Figure 4 shows the results of the survey (n=193). The X-axis reflects the different experiences of usage of the cups, and on the Y-axis the average perception of these experiences is shown based on a Likert scale (1. Strongly disagree; 2. Disagree; 3. Neither agree nor disagree; 4. Agree; 5. Strongly agree). For example, this means that students in Wageningen disagree (2,02) on perceiving a plastic cup as a positive experience.

The survey consisted of multiple-choice questions and reverse questions to verify the answers. In the results showed that the general experience of plastic cups was negative, but the experience of the KeepCup was perceived as positive. The consumers appeared to be unsure in the case of the paper cup. This uncertainty reflects that the surveyed consumers do not exactly know the production data of a paper cup.

3.2.2. Results quantitative data

For the criteria *GHG emissions, Water use, Energy use* and *Waste*, quantitative data was used. The quantitative data was derived from three different sources. For the KeepCup it is mostly based on

the KeepCup LCA report published in 2018, which shows data from Australia, the UK and the US. Next to this, three different assembly scenarios (Melbourne, UK and US) are available in the LCA inventory data. For this assessment, the data for assembly in the UK is used. Besides this, the report (KeepCup, 2018) describes intensity use profiles of light use, medium use, and intensive use. These represent respectively 250, 500 and 750 cups of the alternatives; the paper cup and the plastic cup. In this way, the reusability of the KeepCup was taken into account. In this report, the light use of 250 cups is used to compare the two alternatives against the plastic cup. This modelling assumption will naturally influence the results and needs to be considered while using the assessment for further purposes.

For most of the paper cup and PS cup data, an American study of the life cycle inventory of disposables was used (Franklin Associates Ltd., 2006). This study included the cups' production and disposal phases. In order to derive more accurate data, if multiple data sets were available and if the data was comparable in terms of its attributes, the average of the data sets was taken as the used value. A study by van der Harst shows that the use of multiple data sets and modelling choices can actually increase accuracy of the assessment, especially if the research is focused on general processes in the product system (Van der Harst, 2015). The data used for the GHG emissions, Energy consumption, Water use and Waste can be seen in Table 5.

Table 5: Calculated and aggregated data for different criteria per cup

Data for sub-criteria and cups	**KeepCup**	**Paper**	**Plastic**
GHG emissions (CO2-eq)	1,8	5,08	3,28
Energy consumption (kWh)	35,5	148,13	56,60
Water use (m3)	0,5	0,17	0,18
Waste (kg solid waste)	0,06	1,54	0,53
Perception of use	4,18	2,61	1,75

3.3.3. The weighting

The GOW first assigned weightings to the criteria by filling in ratings (1-9) from the scale in presented in the Table 2 in the methodology. The GOW compared the factors relatively by determining how much more severe one factor is to the other. For example, they concluded that environmental factors are approximately 6.25 times more severe than social factors as can be seen in Matrix 1. Next, the GOW assigned weights in a similar fashion to Matrix 2 by comparing the different sub-criteria to each other. Assigning weights from the 1-9 scale resulted in the numbers given in the different cells of the matrix 2.

Matrix 1: Criteria	**Environmental Factors**	**Social Factors**
Environmental Factors	1	6,25/1
Social Factors	1/6,25	1

Matrix 1: Intensity of severity of the ratio between environmental and social factors, filled in by the Green Office.

Matrix 2: Sub-Criteria	Energy Consumption	Water Use	Waste	GHG Emissions	Perception of Use
Energy Consumption	1	1	2	1/5	8
Water Use	1	1	1	1/5	8
Waste	1/2	1	1	1/7	8
GHG Emissions	5	5	7	1	9
Perception of Use	1/8	1/8	1/8	1/9	1

Matrix 2: Intensity of severity of the ratio between the five sub-criteria, filled in by Green Office.

3.3.4. The Normalization

The weightings given to the criteria in matrix 1 and 2 should be normalized. As explained in chapter 2.2 the normalization process goes as follows:

1. Add values of each column (as can be seen in matrix 12)
2. Divide each cell by the total sum of the column

This number then provides outcomes for the normalized matrix of the criteria. In the next step, the final priorities are determined by adding the values of each row. In this way the highest priority relative to the other criteria is calculated.

In the next step the quantitative and qualitative data gathered should be transformed to the same scale as the other matrixes so they can be compared and summed. The values computed after the transformation can are visible in Matrix 3

Matrix 3 can then also be normalized. The normalized matrix for the sub-criteria is then multiplied with the normalized matrix of the GOW's intensity of severity matrix. This produced a matrix showing the overall normalized factors of the GOW and our own expert matrix together. This was then multiplied with the normalized matrix of the ratio between the environmental and social criteria, to create the final matrix which shows the most favourable option of drinking system at WUR. The matrixes can all be found in Annex 2. The results of the final matrix can be seen in matrix 14.

Matrix 3: Data for sub-criteria and cups on a range	KeepCup	Paper	Plastic
GHG emissions (CO2-eq)	1	9	4,5
Energy consumption (kWh)	1	2,5	9
Water use (m3)	9	1	1
Waste (kg solid waste)	1	9	3,5
Perception of use	9	3,8	1,75

Matrix 3: Data for the criteria per cup, on a range of 1-9 relative to each other

Matrix 12: Environmental and Social criteria	Environmental factors	Social factors
Environmental factors	1	6,25
Social factors	0,16	1
SUM of Columns	1,16	7,25

Matrix 12: Intensity of severity for social and environmental factors concerning the plastic cup, paper cup and KeepCup at WUR. Filled in by the Green Office.

Matrix 14: Normalized factors	Environmental	Social	Summed
Keep Cup	2,15	0,34	2,49
Paper Cup	13,37	2,14	15,51
Plastic Cup	8,98	1,44	10,42

Matrix 14: Normalized factors of environmental and social criteria, concerning the plastic cup, paper cup and KeepCup at WUR. Lowest values show the most favourable drinking system:

Finally, figure 5 gives an overview of the most preferable sustainable hot beverage drinking options at WUR. It shows the paper cup to be the most unfavourable, based on our sub-criteria and the ratio between the criteria, where after KeepCup is the most favourable. The plastic cup is most favourable after the KeepCup.

Next to the analysis of which drinking cup at WUR is the most favourable, numbers showing how many times we need to use the KeepCup for it to be more sustainable than a plastic or paper cup were calculated. This is different for each sub-criterium and cannot be summed over all environmental criteria, since the data is given in different units. Table gives insight to the number of times the KeepCup sometimes needs to be reused in order to be at least equal to the amount of GHG emissions, energy, water or waste the same amount of paper/plastic cups would produce.

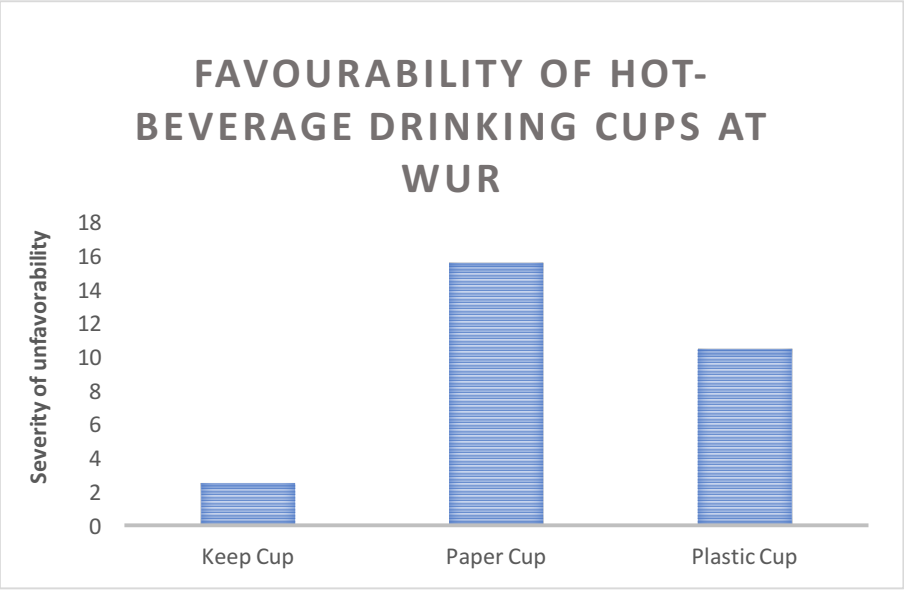

Figure 5: Favourability of different drinking cup options at WUR: the reusable KeepCup, the paper cup and the plastic cup. Severity of favourability is a normalized factor, with 18 as most unfavourable, based on the sub-criteria GHG Emissions, Water use, Energy use.

Table 6: The amount of times which a person needs to reuse its KeepCup for the values to be equal to the same amount of uses of paper or plastic cups.

How many KeepCup uses do we need for it to be equal to using a plastic or paper cup?		
	KeepCup better than paper cup	KeepCup better than plastic cup
GHG Emissions	679	137
Energy Use	125	157
Water Use	524	1984
Waste	10	30

3.3.5. Sensitivity Analysis

In order to verify the outcome of the MCA, a sensitivity analysis was done. Instead of the intensities of favourability given by the Green Office, which displayed their perceived importance of the sub-criteria, the importance of all criteria was set equal to 1. Also, for the ratio between environmental and social factors, a ratio of 0,8 for the 4 environmental sub-criteria (GHG emissions, energy use, water use and waste) was put in the calculations, opposed to a factor 0,2 for the 1 social criteria (perception of use), in order to equalize them. This produced figure 6, which shows again the paper cup as the most unfavourable, then the plastic cup, and finally the KeepCup as the most favourable option. The table matching to this graph is provided in the Appendix. The sensitivity analysis provides us more insight into which one of the cups is actually more sustainable, since the subjectivity of the multi criteria analysis is taken away. Still, the concept sustainability is always perceived and defined by different criteria by different people. However, if it was defined by the equally weighting sub-criteria considered in this research, the KeepCup would be the most sustainable option, where after the plastic cup and lastly the paper cup.

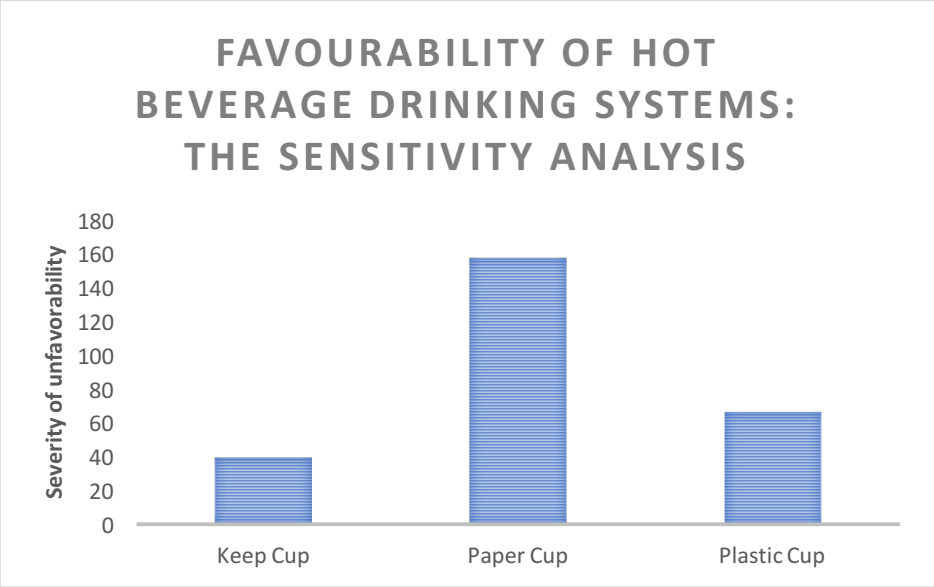

Figure 6: Sensitivity analysis

4. Discussion

4.1. Limitations and implications of the MCA approach

The application of the MCA approach showed implications for the results in the way that all assumptions and decisions made on this study have been based on expertise estimations and findings. The difficulties to get access to data, in order to quantify the criteria, have limited the research frame of the MCA and therefore influenced the research results. Next to difficulties in access, the data found was also very variable, because it came from secondary and different sources. For instance, several LCA studies show inconsistent results, due to differences in the data origins, modelling choices and assumptions made. This variation and uncertainty in the applied data reflect the difficulties of measuring environmental impacts in general. The data was therefore examined of the most adequate applicability in the frame of WUR. For instance, as discussed in the MCA methodology, therefore the data of the production scenario of the KeepCup in the UK was chosen. For the gathered data for the sub-criteria *perception of use,* it should be mentioned that this is based on subjectivity of the respondents. Thus, the results in this report depend on the decisions made on these measurement values. Changing these measurement values and taking different assumptions will affect the outcome of the study. Findings are therefore partly inaccurate and should be framed as statements of trends rather than of absolute results. Thus, the results should be elaborated upon in regenerative studies in order to receive more information and improve the well-founded and resilient results (Van der Harst-Wintraecken, 2015).

Besides limitations in the data, findings of the MCA are based on the assessment of only some criteria and for some life cycle stages. Stages such as packaging, transport and distribution are not considered in this study, because of missing data. It is assumed zero impact in theses stages which implicates increasing uncertainty. There are also differences in the impacts of KeepCups used by consumers. This is because the impact of energy consumption in the use stage differs with every user through different energy productions in each region and different energy amounts to clean the cups (Environmental Edge, 2018). Regarding the differences in waste treatment in many LCA studies, it is difficult to generalize the measurements and apply them to the case of WUR. The differing recycling efficiencies will therefore influence the results.

4.2. Limitations and implications of the Stakeholder Analysis approach

This report only includes the main stakeholders relevant for this research and the Reuse Campaign. The findings of the Stakeholder Analysis are based on online data and interviews. Due to time constraints, limits in communication and in some cases lack of online information, not every stakeholder could be identified in a comparable way. The role of the Executive Board (EB) within the university as well as the campaign could only be assessed by using information and opinions from other stakeholders, namely the Green Office (GOW) and S&I. For the scope of this research OSP Catering was the only caterer of WUR that was analysed. Therefore, the views and interests of OSP Catering should not be considered as the view of other caterers on campus. The inclusion of more caterers was determined as not feasible. OSP Catering was chosen since a connection between research team members and OSP Catering had already been established before research started. Communication was pursued through mail contact; a personal interview could not be scheduled due to time limitations of both manager of OSP Catering and research team. Communication with the GOW and S&I was conducted via mail and interviews. Since the process of campaign designing is still on going, a clear statement and definition about the campaign's main goal and approach could not be delivered by the GOW or S&I. However, it was possible for the GOW to state their opinion on the weights of criteria for the MCA. The students were partly represented through a survey which, however, only focused on their attitude (positive/negative) towards the three different cups and their perceived sustainability. The view of WUR's employees was nor specifically explored.

The view of the GOW on the sustainability of cups was assessed due to their role as commissioner of this report. Their interest is the basis of this research as they intend to use the results directly for their Reuse Campaign. This unequal participation between different stakeholders influences the results and the bias of interest against some stakeholders. The positive interest of consumers is mainly represented by active students, who are already environmentally aware of the issue. The negative interest of students in this issue of sustainability is not researched in this report. The interest of WUR in the campaign was assessed through information given in interview with the GOW and S&I. The interest of OPS Catering in selling the KeepCup remains uncertain since the origin of subsidies for the Keep Cups could not be found.

The hierarchy among stakeholders was illustrated in a simplified way. Since not all actors, that might have a stake in the campaign, could be included in this report further stakeholder implications were not researched. However, it should be mentioned that external stakeholders, e.g. the university's partners for the vending machines on campus, may have the power to influence the design and implementation of the campaign. Furthermore, the definition of sustainability may vary from stakeholder to stakeholder. This implies that the interaction among different stakeholders and their input affect the outcomes of this research therefore also the recommendations on specific cups in the campaign.

4.3. Communication and recommendations

The indicative message deriving from the report, that the reusable KeepCup is the more favourable alternative to both the paper or plastic cups, is a well-founded and resilient recommendation, which should be communicated to the stakeholders. The communication and marketing strategies within the university are important to help spread this message. Next to the favourability of the KeepCup, more information about the environmental impacts of the paper cup should be spread. This is recommended, since the survey showed that consumers at WUR currently perceive this drinking option as the second most sustainable, next to the reusable KeepCup. In the end, improved communication about transparency of the production processes and the environmental impacts of all the cups will imply a more sustainable behaviour and practices among consumers. This will contribute prospectively to a decrease in the number of single-use cups.

As many environmental impacts of life cycle stages fall outside of the universities control, the recommendations focus therefore on the impacts of the *use* stage. The university can influence and control consumers' behaviour by implementing strategies, such as better campaigning and consistent discounts across cafeterias on campus. It is suggested that the sustainable use of the KeepCup should be addressed to consumers in terms of; (i) Cleaning the KeepCup (better washing by hand) and (ii) Reusing the KeepCup (long term use). Still it is in the consumers' individual behaviour, thus intrinsic willingness to change towards more sustainable use of cups should evolve. The KeepCup product itself should be subject of a campaign to make sure it is reaching the target group (students and employees) of the university. The communication and marketing strategies within the university should spread the message through information on the university website, product discounts at the café bars and through information events to educate consumers how to do the right thing.

It is also important to consider, that the only reusable cup that was analysed in this research was the KeepCup. There are alternatives such as bamboo or ceramic cups which were left out of the studies. This means, that apart from KeepCup other sustainable alternatives exist of which the environmental impacts have to be studied as well. The recommendations made in this research paper should be assessed critically and more research studies should be undertaken to support and improve the current recommendations and information level in the long run.

5. Conclusion

In the past years, the production of disposable cups has dramatically increased. This trend of people taking away their hot beverages instead of sitting and consuming them in a cup of glass for some minutes, has as a result to sensitize people to use reusable cups for this need. One of these prominent is the Wageningen University & Research (WUR) and the Green Office Wageningen (GOW) which have established the use of reusable cups on the campus, known as KeepCups, in order to reduce environmental impacts. The KeepCup with the paper cup were the two alternatives for the plastic cup. The main goal of this study was to provide data to the GOW from different perspectives and to conclude which one is the most favourable option. The results will be presented to the next Reuse Revolution Campaign that takes place in WUR's education buildings. The analysed tools implemented for this research were the DPSIR framework, Stakeholder Analysis and Multi-Criteria Analysis.

The DPSIR framework was applied with regard to the increase of production of plastic cups. This was the main concern for disposable cups due to the negative results of pressures, state and impacts on the environment and on human health. From the DPSIR framework it can be concluded that there should be a replacement or reduction of disposable plastic cups. The negative results of production of disposable plastic cups lead to the implementation of the other two alternatives, paper cup and KeepCup. Even though the most important outcome of this analysis was to provide information about environmental and social impacts of plastic cups, it was proved that the plastic cup is the second-best option after KeepCup.

The Stakeholder Analysis was implemented for a detailed approach of all stakeholders which are involved and influenced from the issue. The stakeholders who are mainly affected by using different types of cups in the campus are the GOW, the student party S&I, the Executive Board of WUR, OSP Catering and the students and employers that consume hot beverages. The most important assumption from the Stakeholder Analysis is that the S&I and the GOW stakeholders are the most interested and affected from the results of the research. The GOW aims to reduce the number of disposable cups for hot beverages, and thus waste, at WUR. For S&I, environmental awareness on campus is essential. For WUR it is fundamental to promote a green image from every aspect of activity in the campus, even with inspiring the most sustainable way of consuming your hot beverage. Although, the interest of the university is not as high as the interest of the GOW and the S&I because it is not a coordinator to the planning of the campaign of sustainable measures in the university.

The Multi-Criteria Analysis was based on the interest and the guidance of the GOW for specific criteria for the most sustainable use of cups. The first one was the environmental factor which was subdivided to energy consumption, water use, waste and GHG emissions. The second one was the social factor which was about the students and employees' perception of the use of the three different cups. The results from this survey were indicating that KeepCup was the most sustainable option, followed by paper cup and plastic cup was the least sustainable one. Taking all the above factors into account, the results showed that the paper cup is the most unsustainable in comparison with KeepCup which is the most sustainable. The plastic cup is worse than the KeepCup but preferable to the paper cup.

In conclusion, in this research it was assessed which cup of coffee would be advisable to consume while least impacting the environment. In this way we want to show that everyone can contribute for the best of this world, from small daily things that could make a difference. The majority of the respondents of the survey, believed that KeepCup was the best option and plastic disposable cups were the most negative. The results proved that paper cup is the least sustainable option. This outcome should not encourage consumers to use more plastic disposable cups but to rethink which is the most sustainable way to drink your coffee. In our case the best alternative is the KeepCup, but each student might inspire and find an even better option. It is up to you to be part of a problem but also to be part of the solution.

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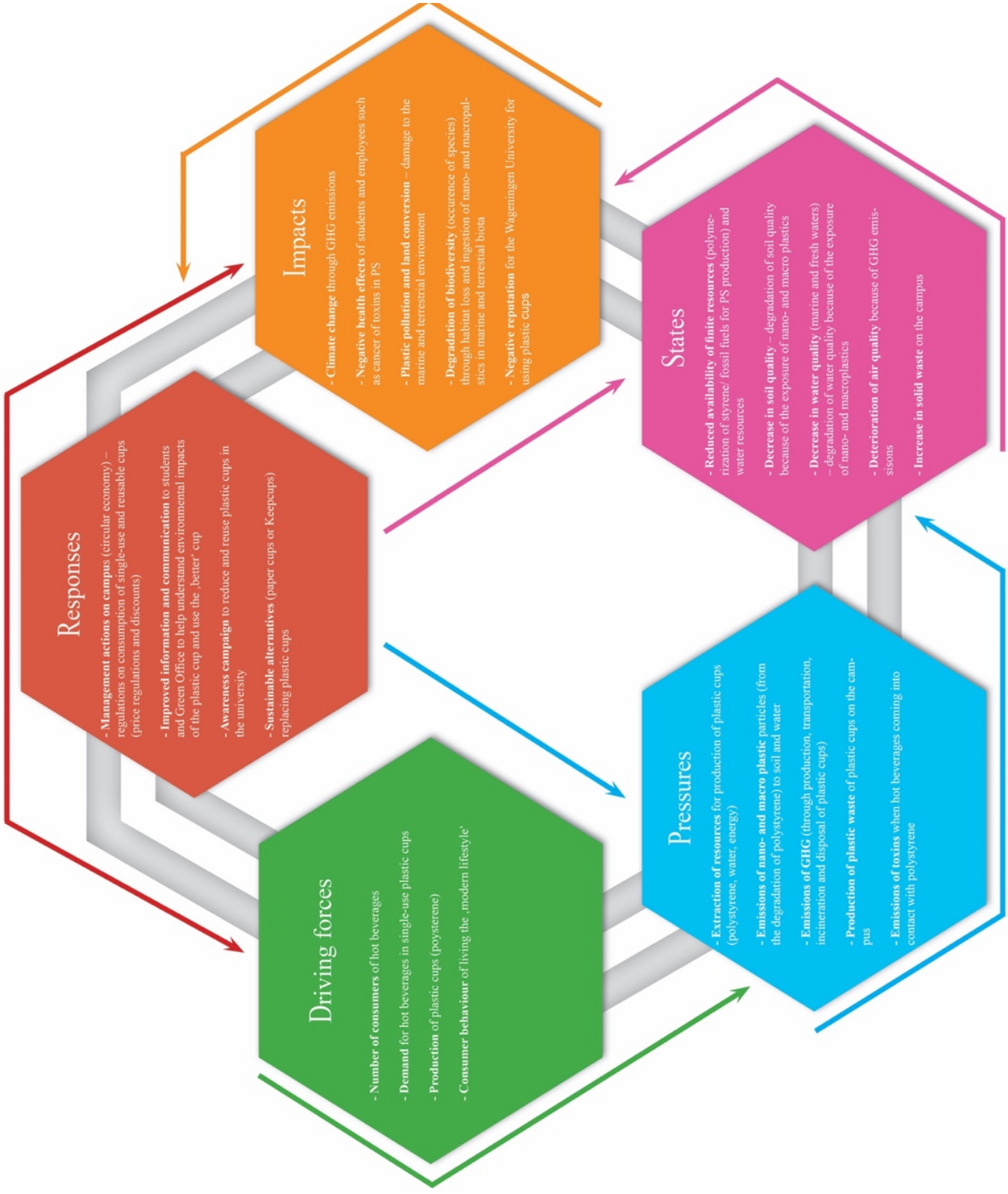
Annexes

Annex 1: DPSIR framework of the benchmark plastic cup



Annex 2: Matrices used in the MCA

Matrix 1: Criteria	Environmental Factors	Social Factors
Environmental Factors	1	6.25
Social Factors	0,16	1

Matrix 1: Intensity of severity of the ratio between environmental and social factors, filled in by the Green Office.

Matrix 2: Sub-Criteria	Energy Consumption	Water Use	Waste	GHG Emissions	Perception of Use
Energy Consumption	1	1	2	1/5	8
Water Use	1	1	1	1/5	8
Waste	1/2	1	1	1/7	8
GHG Emissions	5	5	7	1	9
Perception of Use	1/8	1/8	1/8	1/9	1

Matrix 2: Intensity of severity of the ratio between the five sub-criteria, filled in by Green Office.

On a range	KeepCup	Paper	Plastic
GHG emissions (CO2-eq)	1	9	4,5
Energy consumption (kWh)	1	2,5	9
Water use (m3)	9	1	1
Waste (kg solid waste)	1	9	3,5
Perception of use	9	3,8	1,75

Matrix 3: Data of table 1, on an intensity range of 1-9.

Matrix 4: GHG Emissions	**Keep Cup**	**Paper Cup**	**Plastic Cup**
Keep Cup	1	0,111111111	0,222222222
Paper Cup	9	1	2
Plastic Cup	4,5	0,5	1
SUM Of Columns	14,5	1,611111111	3,222222222
Matrix 5: Energy Consumption	Keep Cup	Paper Cup	Plastic Cup
Keep Cup	1	0,4	0,111111111
Paper Cup	2,5	1	0,277777778
Plastic Cup	9	3,6	1
SUM Of Columns	12,5	5	1,388888889
Matrix 6: Water use	Keep Cup	Paper Cup	Plastic Cup
Keep Cup	1	9	9,00
Paper Cup	0,111111111	1	1
Plastic Cup	9,00	1	1
SUM Of Columns	10,11111111	11	11,00
Matrix 7: Waste	Keep Cup	Paper Cup	Plastic Cup
Keep Cup	1,00	0,11	0,29
Paper Cup	9,00	1,00	2,57
Plastic Cup	3,50	0,39	1,00
SUM of Columns	13,50	1,50	3,86
Matrix 8: Perception of use	Keep Cup	Paper Cup	Plastic Cup
Keep Cup	1,00	2,37	5,14
Paper Cup	0,42	1,00	2,17
Plastic Cup	0,19	0,46	1,00
SUM of Columns	1,62	3,83	8,31

Matrix 3 to 8: Calculated factors of data on a range (1-9) relative to each other.

Normalized Matrix 4: GHG Emissions	**Keep Cup**	**Paper Cup**	**Plastic Cup**	**Priorities**
Keep Cup	0,06896552	0,068965517	0,068965517	0,20689655
Paper Cup	0,62068966	0,620689655	0,620689655	1,86206897
Plastic Cup	0,31034483	0,310344828	0,310344828	0,93103448
Normalized Matrix 5: Energy Consumption	Keep Cup	Paper Cup	Plastic Cup	Priorities
Keep Cup	0,08	0,08	0,08	0,24
Paper Cup	0,2	0,2	0,2	0,6
Plastic Cup	0,72	0,72	0,72	2,16
Normalized Matrix 6: Water use	Keep Cup	Paper Cup	Plastic Cup	Priorities
Keep Cup	0,0989011	0,01010101	0,02020202	0,12920413
Paper Cup	0,89010989	0,090909091	0,181818182	1,16283716
Plastic Cup	0,44505495	0,045454545	0,090909091	0,58141858
Normalized Matrix 7: Waste	Keep Cup	Paper Cup	Plastic Cup	Priorities
Keep Cup	0,07	0,07	0,07	0,22
Paper Cup	0,67	0,67	0,67	2,00
Plastic Cup	0,26	0,26	0,26	0,78
Normalized Matrix 8: Perception of use	Keep Cup	Paper Cup	Plastic Cup	Priorities
Keep Cup	0,62	0,62	0,62	1,86
Paper Cup	0,26	0,26	0,26	0,78
Plastic Cup	0,12	0,12	0,12	0,36

Normalized expert matrices 3-8. Factor devided by sum of columns.

Overview normalized matrices 4-8					
Expert Sub-Criteria	Energy Consumption	Water Use	Waste	GHG Emissions	Perception of Use
Keep Cup	0,24	0,12920413	0,22	0,20689655	1,86
Paper Cup	0,6	1,16283716	2,00	1,86206897	0,78
Plastic Cup	2,16	0,58141858	0,78	0,93103448	0,36

Overview normalized expert matrices 4-8

Normalized Sub-Criteria by Green Office	Energy Consumption	Water Use	Waste	GHG Emissions	Perception of Use
Energy Consumption	0,131147541	0,123076923	0,179775281	0,12092131	0,2352941
Water Use	0,131147541	0,123076923	0,08988764	0,12092131	0,2352941
Waste	0,06557377	0,123076923	0,08988764	0,08637236	0,2352941
GHG Emissions	0,655737705	0,615384615	0,629213483	0,60460653	0,2647059
Perception of Use	0,016393443	0,015384615	0,011235955	0,0671785	0,0294118

Normalized Matrix 2: Normalized factors filled in by the Green Office.

Matrix 9: Green Office x Expert normalized factors	Energy Consumption	Water Use	Waste	GHG Emissions	Perception of Use	Sum of row
Keep Cup	0,18965164	0,090485208	0,133378847	0,57303066	0,2590595	1,24560585
Paper Cup	0,474129101	0,814366875	1,200409625	5,15727598	0,1093807	7,75556225
Plastic Cup	1,706864762	0,407183437	0,466825965	2,57863799	0,0503727	5,20988483

Matrix 9: Green Office normalized matrix

Matrix 10: Normalized factors	Environmental	Social	Summed
Keep Cup	2,15	0,34	2,49
Paper Cup	13,37	2,14	15,51
Plastic Cup	8,98	1,44	10,42

Matrix 10: The result of matrix 9 * Normalized matrix 1. Normalized factors of environmental and social criteria, concerning the plastic cup, paper cup and KeepCup at WUR. Lowest values show the most favorable drinking system.

Data tables

	KeepCup	Paper	Plastic
GHG emissions (CO2-eq)	1,8	5,081182509	3,278877236
Energy consumption (kWh)	35,5	148,1343367	56,59571116
Water use (m3)	0,5	0,174353281	0,178541077
Waste (kg solid waste)	0,063	1,536506604	0,527188483
Perception of use	4,18	2,61	1,75

Table 1: Calculated and aggregated data for different criteria per drink system.

How much KeepCup uses do we need for it to be better than a plastic or paper cup?		
	KeepCup better than paper cup	KeepCup better than plastic cup
GHG Emissions	679,4	137,2
Energy Use	124,5	156,8
Water Use	523,7	1984,1
Waste	10,3	29,9

Table 2: How much KeepCup uses do we need for it to be better than a plastic or paper cup? Assessed per criteria.