Defining sustainability and developing a matrix for sustainable supplier selection for the Student Services Organisation Tübingen-Hohenheim

From defining sustainability to developing a sustainability matrix with relevant themes and sub-themes for sustainable supplier selection at the food sector of the Student Services Organisation Tübingen-Hohenheim

Bachelor Thesis

Rottenburg am Neckar, 11 May 2017

Author:	Myrthe Baijens 930228001 Hogeschool Van Hall Larenstein
Employer:	S. Bold Hochschule für Forstwirtschaft Rottenburg
Tutors:	X. Klijnsma Hogeschool Van Hall Larenstein J. van Belle Hogeschool Van Hall Larenstein

van hall larenstein university of applied sciences

Hochschule für Forstwirtschaft Rottenburg
Hochschule für Angewandte Wissenschaften

Foreword

This thesis aims to give an insight into what sustainability means and puts sustainability into practice by developing a tool for sustainable supplier selection at the food supply sector of the Student Services Organisation Tübingen-Hohenheim (StuWe), Germany. This thesis forms the last part of my course 'Environmental Sciences' at the college Hogeschool van Hall Larenstein in Leeuwarden, the Netherlands.

With my background as a climate activist, it was very challenging to enter the world of the StuWe which is so different from what I am familiar with. As an activist, I see a world that is headed for almost four degrees of global warming by the end of the century and I take part in and organise actions to put pressure on politics and businesses to take action on climate change. Through this thesis, I learned that in daily practice it is much harder for the StuWe to find suppliers which deliver the required products in the exact quantities and qualities at a low price *and* in addition deliver regional, seasonal and fresh food products which were produced with the lowest impact possible on climate change, biodiversity and other sustainability themes. Suppliers do not even have to report on their actions on sustainability, which makes their sustainability reports very different and thereby hard to compare. With this thesis, I have created a tool with which to assess the sustainability reports of potential suppliers. Thereby, the StuWe and also other organisations can compare potential suppliers and choose the most sustainable one.

I would like to thank my interlocutors at the StuWe for the insight they gave me in the differences between theory and practice of sustainable supplier selection, for accompanying and examining my work and for the detailed feedback sessions. Next, I would like to thank my tutors X. Klijnsma and J. van Belle from Hogeschool van Hall Larenstein for their constructive feedback and guidance throughout the period of writing my thesis. I would like to thank my employer S. Bold from the college Hochschule für Forstwirtschaft Rottenburg for his pragmatic and strategic attitude and discussions about taking one step at the time toward sustainability instead of trying to get there in one big jump. I must admit that the latter one is unrealistic and each step brings the world closer to sustainability. But there is a difference between walking and running. Looking at the rapidly rising concentrations of greenhouse gases in the atmosphere and at the rate of biodiversity loss, it is definitely time to run.

My dear friends A.R. de Wolff and R. van der Wal deserve a big thank you for all their help and support whenever I needed it. I say a big thank you to my dear friend M-A. Claus for helping me with Microsoft Excel. I say many thanks to my friend S. Hübel for correcting my English. Finally, I would like to say a warm thank you to my boyfriend E. Bade for cooking for me so I could work longer, providing me with chocolate and tea and not the least for his critical reflections.

I wish everyone a good time reading my thesis.

Myrthe Baijens

Rottenburg am Neckar, 11 May 2017

Abstract

In this study, a comprehensive definition of sustainability was created and a sustainability matrix and calculation tool were developed which can be used for sustainable supplier selection at the food sector of Student Services Organisation Tübingen-Hohenheim (StuWe).

For the definition of sustainability, the original definition by the World Commission of Environment and Development, the United Nations (UN) Sustainable Development Goals (SDGs) and definitions from the scientific community were reviewed and analysed on which characteristics of definitions of sustainability they contain and which of these are used the most. With the mostly used characteristics of sustainability, a new definition was created which reflects the original definition, the SDG's of the UN and definitions from the scientific community:

> Sustainability is a dynamic condition in the global society supported and maintained by suitable institutions at all levels in which the integrity of the environment i.e. ecosystems, global life-supporting systems and the natural resource base is respected so it can continue into the future to regenerate the services necessary for economic activity, which has the purpose to increase prosperity within the carrying capacity of the environment.

For the sustainability matrix and calculation tool, the most important sustainability themes and sub-themes were derived from the sustainability definition. For the sub-themes, the relevance for potential suppliers of the StuWe was discussed. Sub-themes were considered relevant when potential suppliers directly influence them. The relevant sub-themes were further elaborated and goals for potential suppliers and indicators to measure the progress of potential suppliers were developed. Then the relative importance was determined which depended on their impact on people and the environment, the scale on which the impacts occur and the influence potential suppliers have on the sub-themes. The relative importance was expressed in a weighting factor. With the themes, sub-themes, their goal and relative importance, the sustainability matrix was created.

Accompanying the matrix, the Excel model "Sustainability score calculation tool" was created with which an overall score on sustainability of potential suppliers can be calculated. To do so, the sustainability reports of the potential suppliers are assessed on the relevant sub-themes using the goal and indicators of the sub-themes, which are included in the calculation tool. The score per sub-theme can be filled into the calculation tool, which then calculates the overall sustainability score. With the sustainability score of several potential suppliers, the most sustainable supplier can be selected.

An example of the application of the sustainability matrix and calculation tool is given, where the sustainability report of an existing supplier of the StuWe was assessed and a sustainability score could be calculated.

A point of discussion for the matrix and calculation tool is, that these were based on theory and still need to be proved to be useful in practice. The themes, sub-themes, their goals, indicators and relative importance need to be evaluated in cooperation with (potential) suppliers of the StuWe in order to check how meaningful the themes and sub-themes are for them and if the indicators are suitable to measure progress towards the goals.

Matrix for sustainable supplier selection at the food sector of the StuWe

Themes	**Sub-themes** The goal for potential suppliers for the sub-theme is written below the sub-theme. In the lower right corners of the sub-themes, their relative importance is expressed as a number.	
Human needs	**Living wage** At least a living wage is paid to all employees, which is set at the at-risk-of-poverty threshold (60% of the median equivalised disposable income level in the EU for families with two children) 11	
Integrity of ecosystems and global life-supporting systems	**Climate change** Elimination or full compensation of all GHGE within ten years i.e. by 2027 12	**Biogeochemical flows: Phosphorous and Nitrogen cycles** No P surplus and a N surplus below 10 kg N/ha/y 12
	Biodiversity No contribution to biodiversity loss by committing to halt business expansion on natural land and restoring premises where possible to the naturally occurring habitat 8	**Novel entities** Reduction of emissions and waste production of substances which are harmful to the environment and of which the effects on the environment are unknown as much as possible 10
Integrity of the natural resource base	**Renewable resources** Reduction of the use of renewable resources as much as possible and use of renewable resources where possible from sources which are managed in such a way that the providing ecosystem is conserved 9	**Non-renewable resources** Reduction of the use of primary non-renewable resources as much as possible 8

List of abbreviations

AOD: Aerosol Optical Depth
AR: Assessment Report
art.: article
BII: Biodiversity Intactness Index
BMEL: Bundesministerium für Ernährung und Landwirtschaft
BLAG: Bund-Länder-Arbeitsgruppe zur Evaluierung der Düngeverordnung
CH_4: methane
CFCs: chlorofluorocarbons
CO_2: carbon dioxide
DU: Dobson Units
EEA: European Environment Agency
E/MSY: extinctions per million species per year
ES: Earth System
EU: European Union
ETI: Ethical Trade Initiative
FMLSA: Federal Ministry for Labour and Social Affairs
GDP: gross domestic product
GHG: greenhouse gas
GHGE: greenhouse gas emissions
Gt: gigatonnes
ha: hectare
IPCC: Intergovernmental Panel on Climate Change
IRP: International Resource Panel
IUCN: International Union for Conservation of Nature
MEA: Millennium Ecosystem Assessment
MFA: Material Flow Analysis
N: nitrogen
N/A: not applicable
N_2O: nitrous oxide
OECD: Organisation for Economic Co-operation and Development
OJ L: Official Journal Legislation
OWG: Open Working Group
OSH: occupational safety and health
P: phosphorus
PB: Planetary Boundary
ppm: parts per million
SDGs: sustainable development goals
StuWe: Studierendenwerk Tübingen-Hohenheim
Tg: Tera grams; 10^{12} grams
UN: United Nations
UNCED: United Nations Conference on Environment and Development
UN DESA: United Nations Department of Economic and Social Affairs
UNEP: United Nations Environment Programme
W: Watt
WCED: World Commission on the Environment and Development
WSI: Wirtschafts- und sozialwissenschaftliches Institut
WWF: World Wildlife Fund

Table of contents

1. Introduction

Sustainability: what is the first thought that comes to mind when you hear that term? You will likely think of it as a positive term, the phrase 'people, planet, profit' comes to mind which stands for the social, environmental and economic pillars of sustainability or you think of it as a buzzword of which the meaning has become quite empty. The definition which is most often referred to is from the World Commission on the Environment and Development (WCED), which is at the same time the first definition. The WCED introduced the concept of sustainable development in its report 'Our Common Future' in 1987 (WCED 1987, 41):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

It was a positive term that was in need of being defined more specifically. Since then, there have been numerous organisations and scientists doing just that, either by giving definitions, principles, objectives or indicators, or a combination of those. Now there are numerous definitions, some more specific than others, and one still doesn't know what it means. At the same time, many organisations and businesses use the term without specific definitions, so one can only guess what it might mean.

1.1 Student Services Organisation Tübingen-Hohenheim

In Germany, "Studierendenwerke" (student services organisations) are organisations that provide facilitating services to higher education in the areas of student accommodation, college catering, the financing of studies etc. (Deutsches Studentenwerk n.d.). The Studierendenwerk Tübingen-Hohenheim (hereafter referred to as "StuWe") offers these services to the universities and colleges in the region of the cities Tübingen and Hohenheim. As of 2015, the StuWe operated 10 canteens and 15 cafeterias at two universities and six colleges, in which 1.672.843 meals were served (StuWe 1 2016).

In an interview with the StuWe (StuWe 2 2016), the current approach and difficulties with addressing sustainability in the supplier selection process were explained: because of the sheer number of meals which have to be served at affordable prices, there are strict constraints on the suppliers of food products: the suppliers should be able to deliver large enough quantities of foods which are processed as far as possible so that the StuWe has the smallest expenditure of work to prepare all the meals. This means that small local suppliers are often not an option because they cannot deliver the needed quantities and do not have the workforce to process the foods to the required level. As a result, a lot of frozen foods of large suppliers are used. Every time the StuWe invites tenders it requests the potential suppliers' sustainability reports. These are assessed individually. However, no indicators have been developed and are deployed to assess the sustainability reports.

1.2 Objectives

Given the multitude of possible definitions of sustainability, what is a clear and meaningful definition and what would this definition mean for the selection of suppliers of food products for the college canteens and cafeterias the StuWe operates? What are the most important themes which should be considered in sustainable supplier selection at the StuWe and with which indicators could those themes be measured?

These questions result in the following objectives for this study:

1. To create insight in what sustainability means and thereby to come to a new comprehensive definition which reflects the original meaning, the worldwide agreement on the United Nations (UN) Sustainable Development goals (SDGs) and definitions of the scientific community;

2. To identify the most important sustainability themes and sub-themes and their relative importance and the sub-themes which are relevant for potential suppliers of the StuWe;
3. To create a sustainability matrix with the most important themes with goals and indicators to measure the sustainability of potential suppliers of the StuWe in order to choose the most sustainable supplier.

1.3 Research questions

Following the objectives of this study, the following central question is formulated:

Central question:
How could sustainability be defined and how could a sustainability matrix of themes, indicators and goals be designed and used for sustainable supplier selection at the food sector of the StuWe?

To answer the central question, the following sub-questions will be answered:

Sub-questions:
1. How could sustainability be defined?
2. What themes and sub-themes should a sustainability matrix for sustainable supplier selection at the food sector of the StuWe consist of?
3. With what indicators could the sub-themes be measured and what should be the goals?
4. What is the relative importance of the sub-themes?
5. How could a sustainability matrix be designed and used for sustainable supplier selection at the food sector of the StuWe?

1.4 Reader's guide

In chapter 2 the methodology for this study will be described. In chapter 3, called "Defining sustainability", the first research question will be answered. In chapter 4, which describes the most important sustainability themes and sub-themes, research questions two, three and four will be answered. In chapter 5 a sustainability matrix is developed, by which the fifth research question will be answered. In chapter 6 an example of the application of the sustainability matrix is given. In chapter 7 the final conclusion, the central question of this study will be answered. In chapter 8 the study will be discussed and recommendations for further research will be made.

2. Methodology

In the first part, a literature review will be conducted to create an overview of the most important sustainability definitions and characteristics of sustainability definitions, with which a new definition of sustainability will be created. In the second part, the most important sustainability themes and sub-themes will be identified based on the literature review. For each sub-theme the relevance for potential suppliers will be discussed. For the relevant sub-themes goals and indicators will be developed and the relative importance of the sub-themes will be determined considering the literature review. In the third part, a sustainability matrix is created using the themes and relevant sub-themes. In the final part, the sustainability matrix will be applied on one supplier. Below, the methodology for each part is described.

2.1 Part one: defining sustainability

This part consists of three steps: the first is to conduct a literature review on sustainability, the second is to create an overview of characteristics of sustainability identified in the review and the third is to create a new definition of sustainability using the most important characteristics of sustainability.

For the literature review, the initial definition of sustainability by the World Commission of Environment and Development will be reviewed, in order to get insight in the original meaning of the term. Then, the SDGs from the UN will be reviewed because they represent worldwide agreement from governments, civil society and businesses on the goals of sustainability. After that, recent definitions from the scientific community will be reviewed to see how the scientific community conceives of the term. At last, the Planetary Boundaries (PBs) concept will be presented because the PBs can be seen as the boundaries of sustainability.

Throughout the literature review, characteristics that make up the definitions will be gathered. For the first definition, all characteristics that the definition consists of will be identified. In all the following definitions, only additional characteristics will be identified. After the literature review, an overview of all characteristics will be created in which the characteristics will be sorted. The characteristics that are most important for defining sustainability will be distinguished.

In the conclusion of this part, a new definition of sustainability will be created using the most important characteristics in such a way that it reflects the original meaning, the SDGs and scientific understanding best. This definition will be used throughout the rest of the study.

2.2 Part two: sustainability themes and sub-themes for sustainable supplier selection at the food sector of the StuWe

This part consists of four steps: the first step is to determine the most important sustainability themes and identify corresponding sub-themes. In the second step, the relevance of the sub-themes for potential suppliers is discussed and relevant sub-themes are selected which will be used throughout the rest of this study. The third step is to describe the relevant sub-themes, to determine the corresponding goals and to develop indicators with which progress to the goal is measured. In the fourth step, the relative importance of the sub-themes is determined.

The most important themes will be derived from the most important sustainability characteristics. The corresponding sub-themes will be derived from the other characteristics. The relevance of the sub-themes depends on whether a sub-theme is directly influenced by potential suppliers.

After the relevant sub-themes have been distinguished, a literature research is conducted to describe each sub-theme, to identify the goals for potential suppliers that are needed to reach sustainability

and to identify the indicators which measure progress by potential suppliers to the goals. For the literature research, the same sources are used as for the literature research in part one as well as additional sources referred to in the original sources and additional sources which will be searched using the name of the sub-theme in combination with goal or indicator.

With the descriptions of the relevant sub-themes and the definition of sustainability created in part one, a methodology will be developed to systematically determine the relative importance of the relevant sub-themes.

The relative importance of the sub-themes will be expressed in numerical weighting factors: The weighting factors will be determined based on the descriptions of the sub-themes and at the definition of sustainability created in part one.

2.3 Part three: matrix for sustainable supplier selection at the food sector of the StuWe

This part consists of three steps: the first step is to develop a methodology to calculate the sustainability score for the potential suppliers and a calculation tool. The second step is to design a matrix with the themes and relevant sub-themes, goals and indicators in such a way that it supports the calculation of the sustainability score. In the third step, a step by step guide is created for the StuWe which describes how to use the matrix and calculation tool to calculate the sustainability score of potential suppliers.

The methodology for calculating the sustainability score of potential suppliers of the StuWe should meet the following criteria:

- Provide a score which depicts how well potential suppliers address the relevant sub-themes;
- It should be applicable on all potential suppliers irrespective of the products they supply;
- The score should provide a comparison of the sustainability of several potential suppliers of similar products;
- Take into account the relative importance of the sub-themes.

The sustainability matrix should meet the following criteria:

- The matrix should serve as a support for the calculation tool for the sustainability score;
- A title and sub-title should describe the purpose of the matrix;
- The matrix should be in line with the definition of sustainability from part one;
- The sustainability themes and sub-themes should be clear at a glance;
- The goals and indicators should be portrayed;
- The relative importance of the sub-themes should be portrayed.

The step by step guide should be set up in such a way that it describes all steps which need to be taken to calculate the sustainability scores of several potential suppliers that are to be compared: from which information sources that need to be requested of potential suppliers to the selection of the most sustainable supplier.

2.4 Part four: example application of the sustainability matrix

This part consists of one step: to follow the step by step guide and determine the sustainability performance of an existing supplier. The data about the sustainability performance of the supplier will be derived from the sustainability report and other information sources provided by the StuWe.

3. Defining sustainability

In this chapter the first research question is answered: how can sustainability be defined? The chapter starts with a literature review of definitions of sustainability in paragraph 3.1. Then in paragraph 3.2 an overview is created of characteristics of the definitions that are gathered throughout the literature review. In the conclusion, paragraph 3.3, a new definition of sustainability is created which comprises of the most important the sustainability characteristics of paragraph 3.2.

3.1 Literature review

3.1.1 First definition of sustainable development

In 1983, the General Assembly of the UN established a special commission with the task of assembling a report with global perspectives on the environment and proposed strategies for sustainable development to the year 2000 and beyond (UN DESA 1 n.d.). This commission was later named the World Commission of Environment and Development (WCED) and was led by the then prime minister of Norway, G.H. Brundlandt (Lexikon der Nachhaltigkeit 2015). The report of the WCED, called *From one Earth to one World: Our Common Future*, also known as the *Brundtland Report*, was published in 1987 (UN DESA 1 n.d.). It was the first report to develop the concept of sustainable development (Lexikon der Nachhaltigkeit 2015). It defines sustainable development as follows (WCED 1987, 41):

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

The report indicates that the definition contains two concepts: "the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environmental resources and the ability of the biosphere to absorb the effects of human activities" (WCED 1987, 41).

The report describes sustainable development as a harmony between the resources demands and the changing productive potential of the ecosystems. It indicates that it should not be seen as a fixed state, rather a process of technological and societal development which are made consistent with present and future needs within the potential of ecosystems. (WCED 1987, 16)

From the definition and the above exemplifications on it by the WCED, the following characteristics of sustainable development can be identified: meeting human needs, not compromising others to meet their needs, prioritising the essential needs of the poor, the long-term, limited environmental resources, limited resilience of the biosphere to human activity, staying within the potential of ecosystems, process, technology and social organisation to create a harmony between the social and environmental characteristics.

3.1.2 The Sustainable Development Goals

At the United Nations Conference on Sustainable Development in 2012, member states agreed to develop a set of SDGs which were to be integrated in the UN development agenda after 2015 and build on the Millennium Development Goals. In January 2013, the Open Working Group (OWG) of the General Assembly of the UN was established with the task of making a proposal for the SDGs. (UN DESA 2 n.d.) The OWG consisted of 30 seats; each seat was shared by a number of member states (UN OWG on SDGs 2013). In the process of establishing the proposal for the SDGs, civil society, the scientific community and all relevant stakeholders were involved (UN DESA 2 n.d.). In September 2015, the UN Summit for Sustainable Development was held where the 2030 Agenda for Sustainable Development was adopted, which included 17 SDGs and 169 goals (UN DESA 3 n.d.).

The goals are (UN DESA 3 n.d.):

1. **No poverty**: end poverty in all its forms everywhere
2. **Zero hunger**: end hunger, achieve food security and improve nutrition and promote sustainable agriculture;
3. **Good health and well-being**: ensure healthy lives and promote well-being for all and at all ages;
4. **Quality education**: ensure inclusive and equitable quality education and promote life-long learning opportunities for all;
5. **Gender equality**: achieve gender equality and empower all women and girls;
6. **Clean water and sanitation**: ensure availability and sustainable management of water and sanitation for all;
7. **Affordable and clean energy**: ensure access to affordable, reliable, sustainable and modern energy for all;
8. **Decent work and economic growth**: promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all;
9. **Industry, innovation and infrastructure**: build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation;
10. **Reduced inequalities**: reduce inequality within and between countries;
11. **Sustainable cities and communities**: make cities and human settlements inclusive, safe, resilient and sustainable;
12. **Responsible consumption and production**; ensure sustainable consumption and production methods;
13. **Climate action**: take urgent action to combat climate change and its impacts;
14. **Life below water**: conserve and sustainably use the oceans, seas and marine resources for sustainable development;
15. **Life on land**: protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and biodiversity loss;
16. **Peace, justice and strong institutions**: promote peaceful and inclusive societies for sustainable development, promote access to justice, for all and build effective, accountable and inclusive institutions at all levels;
17. **Partnerships for the goals**: strengthen the means of implementation and revitalise the global partnership for sustainable development

The SDGs elaborate on the sustainability characteristic of meeting human needs, identified in paragraph 3.1.1: no poverty, zero hunger, good health and wellbeing, quality education, gender equality, clean water and sanitation, affordable and clean energy, reduced inequalities, and access to justice.

The SDGs add some economic characteristics of sustainability: decent work and economic growth, industry, innovation and infrastructure and responsible consumption and production.

The SDGs elaborate on the sustainability characteristic of “limited resilience of the biosphere to human activity” by setting climate action as a goal: the climate system can be seen as a part of the biosphere with limited resilience to human activity.

Goals 15 and 16, Life on Land and Life below Water, elaborate on the characteristic “staying within the potential of ecosystems” : conserve and sustainably use the oceans, seas and marine resources, combat desertification and halt and reverse land degradation and biodiversity loss.

The SDGs elaborate on the sustainability characteristic of "technology and social organisation to create a harmony between the social and environmental characteristics" with the goals to create partnerships for the goals and to build institutions for sustainable development, therefore combining not only social and environmental characteristics, but in fact, all characteristics.

3.1.3 Definitions from the scientific community

In their article "How to understand and measure environmental sustainability: indicators and goals" Moldan et al. (Moldan, Janousková and Hák 2012) give an overview of many definitions of sustainability and economic, environmental and social sustainability. That is why this article was chosen to get an overview of definitions from the scientific community. The definitions with their sources as cited by Moldan et al. are summarised in tables 1-4. They also cite the definition of the WCED, which will not be repeated here. After each table, the sustainability characteristics in that table will be discussed.

Moldan et al. describe the difference between sustainability and sustainable development as follows: "the meaning of sustainable development and sustainability is not identical, even though the fundamental sense is basically the same. While sustainability denotes a system property referred to as quality, we believe that the key to the sustainable development concept is provided by the already quoted Brundtland definition and Article 1 of the Rio Declaration (UNCED, 1992)" (Moldan, Janousková and Hák 2012, 4). Sustainability could hence be interpreted as describing properties of a system such as society, a business or other organisation whereas sustainable development describes how a sustainable system develops over time.

Table 1 Definitions of sustainability and sustainable development cited by (Moldan, Janousková and Hák 2012, 4-5)

Definition
IUCN, UNEP and WWF, 1980: "For development to be sustainable it must take account of social and ecological factors, as well as economic ones".
UNCED, 1992: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature".
Goodland and Ledec, 1987: "Sustainable development means the use of renewable natural resources in a manner that does not eliminate or degrade them or otherwise diminish their usefulness for future generations … using non-renewable (exhaustible) mineral resources in a way which does not unnecessarily preclude easy access to them by future generations… a sufficiently slow-rate of depletion of non-renewable energy resources to ensure the high probability of an orderly societal transition to renewable ones".

One of the main characteristics when sustainability is defined, is the use of the three pillars of sustainability "economic, environmental and social", or "people, planet, prosperity" which were introduced at the UN World Summit on Sustainable Development (Moldan, Janousková and Hák 2012, 4). The definition of the IUCN, UNEP and WWF (International Union for Conservation of Nature, United Nations Environment Programme, World Wildlife Fund) specifically mentions the three pillars. However, not all definitions contain all pillars. The definition of the WCED, the Rio Declaration and Goodland and Ledec only contain the social and environmental pillars. Goodland and Ledec give a clear definition of the resources characteristic identified in paragraph 3.1.1 and connect it to the social pillar and put it in the perspective of the long-term. They divide resources into renewable and non-renewable resources, which can be interpreted as sub-characteristics of the resources characteristic.

Table 2 Definitions of social sustainability cited by (Moldan, Janousková and Hák 2012, 5)

Definition
Black, 2004: “The extent to which social values, social identities, social relationships and social institutions can continue into the future”
Torjman, 2000: “From a social perspective in particular, human wellbeing cannot be sustained without a healthy environment and is equally unlikely in the absence of a vibrant economy”
Gilbert, 1996: “Social sustainability requires that the cohesion of society and its ability to work towards common goals be maintained. Individual needs, such as those of health and well-being, nutrition, shelter, education and cultural expression should be met”

Black and Gilbert both define social sustainability in isolation of the other pillars, whereas Torjman defines social sustainability as human wellbeing and states that this depends on the other pillars. Gilbert clarifies the human needs characteristic identified in paragraph 3.1.1 by naming the individual needs. The need of cultural expression can be recognised in Blacks definition as social values, identities, relationships and institutions.

Table 3 Definitions of economic sustainability cited by (Moldan, Janousková and Hák 2012, 5)

Definition
Markandya and Pearce, 1988: “The use of resources today should not reduce real incomes in the future because sustainability requires that the conditions necessary for equal access to the resource base be met for each subsequent generation”
Hamrin, 1983: “Natural resources and the environment constitute the ultimate foundation upon which all future economic activity must be construed. From this, it follows that future economic progress will be increasingly dependent on the sustained integrity of the resource and environmental base”

What is notable about the definitions of economic sustainability, is that they do not describe economic activity in itself, but directly connect it to the environmental and social pillars: resources and the environment are the basis for economic activity with which incomes are generated, which should be guaranteed for the future. Thereby, generating incomes can be identified as another economic characteristic of sustainability.

Moldan et al. also question the focus on economic activity in itself without addressing the environment as well. They point out that economic growth is a universally accepted policy goal, but question whether it should be. They refer to the financial crisis in 2008 and quote the US president Obama saying: “It is simply not sustainable to have an economy where, in one year, 40 per cent of our corporate profits came from a financial sector that was based on inflated home prices, maxed-out credit cards, over-leveraged banks and overvalued assets.” (Moldan, Janousková and Hák 2012, 5)

Moldan et al. name two studies which are examples of what a sustainable economy could look like if the focus shifts away from economic growth: “Prosperity without growth?” by Tim Jackson and “Managing Without Growth” by Peter Victor. As Jackson writes, economic growth is perceived of as leading to an increase in prosperity, which has made it such an important policy goal. Economic growth is measured in the gross domestic product (GDP), which measures economic activity. (Jackson 2008, 3) But, looking at the financial crisis, if that growth comes from bubbles in the financial sector, this growth does not contribute to greater prosperity. For this study, the purpose of economic activity is to increase prosperity. Economic activity should only be increased if this leads to an increase in prosperity. Thus the economic characteristic of sustainability identified in the SDG, economic growth, can be elaborated as: economic growth with the purpose of increasing prosperity,

because economic growth in itself should not be the goal. Prosperity is understood as meeting the human needs as specified for the corresponding sustainability characteristic.

Table 4 Definitions of environmental sustainability cited by (Moldan, Janousková and Hák 2012, 6)

Definition
Goodland, 1995: "Environmental sustainability seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans"
Holdren, 1995: Biophysical sustainability means maintaining or improving the integrity of the life supporting systems of the Earth. Sustaining the biosphere with adequate provisions for maximizing future options includes enabling current and future generations to achieve economic and social improvement within a framework of cultural diversity while maintaining (a) biological diversity and (b) the biogeochemical integrity of the biosphere by means of conservation and proper use of air, water, and land resources.
OECD, 2001: "The strategy defines four specific criteria for environmental sustainability: • Regeneration (renewable resources shall be used efficiently and their use shall not be permitted to exceed their long-term rates of natural regeneration); • Substitutability (non-renewable resources shall be used efficiently and their use limited to levels which can be offset by substitution with renewable resources or other forms of capital); • Assimilation (releases of hazardous or polluting substances into the environment shall not exceed their assimilative capacity); • Avoiding irreversibility."

Of the above definitions of environmental sustainability, only the last focusses only on environmental aspects. Holdren adds the following environmental characteristics to sustainability: improving the integrity of life supporting systems, which means maintaining biodiversity and the biogeochemical integrity of the biosphere. The OECD elaborates the resources characteristic; regeneration, substitutability and assimilation. It reinforces the sub-characteristics of renewable and non-renewable resources and adds a new characteristic to the environmental pillar: avoiding irreversibility.

Besides the definitions of sustainability, Moldan et al. also cite the Millennium Ecosystem Assessment's (MEA) categories of ecosystem services and Daily's nature services with which they create their own definition of environmental sustainability: "maintaining nature's services at a suitable level" (Moldan, Janousková and Hák 2012, 7).

The MEA gives the following four categories of ecosystem services (MEA 2005, 40):

- Provisioning (food, freshwater, wood and fibre, fuel etc.);
- Regulatory (climate regulation, flood regulation, disease regulation, water purification etc.);
- Cultural (aesthetic, spiritual, educational, recreational etc.);
- Supporting (nutrient cycling, soil formation, primary production etc.).

The ecosystems services and the categories in which they are divided, can be seen as an elaboration of the characteristics of staying within the potential of ecosystems and meeting human needs. The ecosystem services are needed to meet human needs.

Moldan et al. name the global life-supporting systems, called Nature services by Daily (Moldan, Janousková and Hák 2012, 6):

- The stratospheric ozone layer;
- The climatic system;
- The hydrological cycle;
- The global biogeochemical cycles;
- Goods provided by the geosphere (mineral resources);
- The three-dimensional open space: land on the Earth's surface and the space beneath and above it.

According to Moldan et. al., environmental sustainability means maintaining ecosystem services and global life-supporting systems. They also signify that this is essential for human wellbeing (Moldan, Janousková and Hák 2012, 6), which indicates a link between social and environmental sustainability.

The global life-supporting systems add important characteristics to sustainability. Proper functioning of these systems is needed for the proper functioning of ecosystems and therefore for meeting human needs.

3.1.4 The Planetary Boundaries concept

The PB concept was developed in 2009 by an interdisciplinary group of renowned scientists hosted by the Stockholm Resilience Centre in collaboration with the Australian National University and the University of Copenhagen (Stockholm Resilience Centre n.d.). The PB concept was presented in a 2009 article (Rockström, et al., Planetary Boundaries: Exploring the Safe Operating Space for Humanity, 2009) and an update was given in a 2015 article (Steffen, et al., Planetary Boundaries: Guiding Human Development on a Changing Planet, 2015).

As is explained in (Steffen, et al. 2015, 1-2), the nine PBs define boundaries for nine biophysical processes which regulate the stability of the Earth System (ES). These are depicted in figure 1. Within these boundaries, indicated by the green zone, human society can develop and thrive safely. Behind the boundaries lie thresholds or tipping points beyond which it is likely that the Earth is much less hospitable, possibly devastating to the development of human societies. Crossing a tipping point means that abrupt and irreversible changes in the ES take place. There is still scientific uncertainty about precisely where the tipping points lie, therefore zones of uncertainty have been defined, the yellow zone in figure 1. The PB lies at the start of the uncertainty zone. At the end of the uncertainty zone, a very high risk of crossing the tipping points exists. For two of the nine biophysical processes no PBs could be defined yet, indicated in grey. For four out of nine biophysical processes, the boundaries have already been crossed.

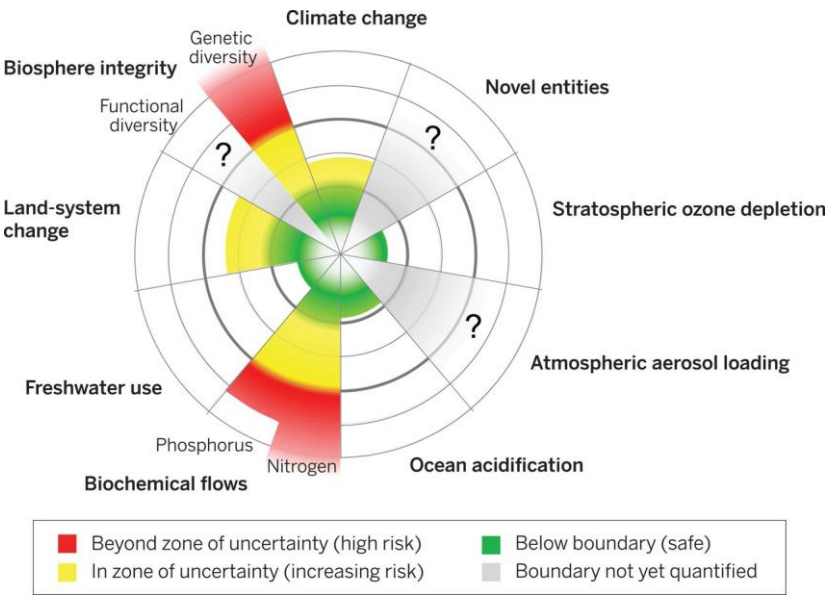

Figure 1 The Planetary Boundaries. Source: (Steffen, et al. 2015, 6)

In table 5 the control variables of each of the nine biophysical processes are given including the current value of the control variables.

Table 5 Planetary boundaries: control variables and current state. Source: adapted from (Steffen, et al. 2015, 4-5)

Biophysical processes	**Control variables**	**PB (zone of uncertainty)**	**Current value of control variables**
Climate change	Atmospheric CO_2 concentration in ppm	350 ppm CO_2 (350 – 450 ppm)	398.5 ppm CO_2
	Energy imbalance at top-of-atmosphere, W m^{-2}	+1.0 W m^{-2} (+1.0–1.5 W m^{-2})	2.3 W m^{-2} (1.1–3.3 W m^{-2})
Change in biosphere integrity	Genetic diversity: Extinction rate	< 10 E/MSY (10–100 E/MSY) but with an aspirational goal of ca. 1 E/MSY (the background rate of extinction loss). E/MSY = extinctions per million species-years	100–1000 E/MSY
	Functional diversity: Biodiversity Intactness Index (BII)	Maintain BII at 90% (90–30%) or above, assessed geographically by biomes/ large regional areas (e.g. southern Africa), major marine ecosystems (e.g., coral reefs) or by large functional groups	84%, applied to southern Africa only
Stratospheric ozone depletion	Stratospheric O_3 concentration, Dobson Units (DU)	<5% reduction from preindustrial level of 290 DU (5%–10%), assessed by latitude	Only transgressed over Antarctica in Austral spring (~200 DU)
Ocean acidification	Carbonate ion concentration, average global surface ocean saturation state with respect to aragonite	≥80% of the pre-industrial aragonite saturation state of mean surface ocean, including natural diel and seasonal variability (≥80%–≥70%)	~84% of the pre-industrial aragonite saturation state

Biophysical processes	Control variables	PB (zone of uncertainty)	Current value of control variables
Biogeochemical flows: P and N cycles	P Global: P flow from freshwater systems into the ocean	11 Tg P $year^{-1}$ (11–100 Tg P $year^{-1}$)	~22 Tg P $year^{-1}$
	P Regional: P flow from fertilizers to erodible soils	6.2 Tg $year^{-1}$ mined and applied to erodible (agricultural) soils (6.2-11.2 Tg year–1). Boundary is a global average but regional distribution is critical for impacts.	~14 Tg P $year^{-1}$
	N Global: industrial and intentional biological fixation of N	62 Tg N $year^{-1}$ (62–82 Tg N $year^{-1}$). Boundary acts as a global 'valve' limiting introduction of new reactive N to Earth System, but regional distribution of fertilizer N is critical for impacts.	~150 Tg N $year^{-1}$
Land-system change	Global: Area of forested land as % of original forest cover	Global: 75% (75–54%) Values are a weighted average of the three individual biome boundaries and their uncertainty zones	62%
	Biome: Area of forested land as % of potential forest	Biome: Tropical: 85% (85–60%) Temperate: 50% (50–30%) Boreal: 85% (85–60%)	
Freshwater use	Global: Maximum amount of consumptive blue water use ($km^3 year^{-1}$)	Global: 4000 km^3 $year^{-1}$ (4000–6000 km^3 $year^{-1}$)	~2600 $km^3 year^{-1}$
	Basin: Blue water withdrawal as % of mean monthly river flow	Basin: Maximum monthly withdrawal as a percentage of mean monthly river flow. For low-flow months: 25% (25–55%); for intermediate flow months: 30% (30–60%); for high-flow months: 55% (55–85%)	
Atmospheric aerosol loading	Global: Aerosol Optical Depth (AOD), but much regional variation		
	Regional: AOD as a seasonal average over a region. South Asian Monsoon used as a case study	Regional: (South Asian Monsoon as a case study): anthropogenic total (absorbing and scattering) AOD over Indian subcontinent of 0.25 (0.25–0.50); absorbing (warming) AOD less than 10% of total AOD	0.30 AOD, over South Asian region
Introduction of novel entities	No control variable currently defined	No boundary currently identified, but see boundary for stratospheric ozone for an example of a boundary related to a novel entity (CFCs)	

The nine biophysical processes for which the PBs have been set, could be understood as processes undermining the integrity of ecosystems and the global life-supporting systems as named by Moldan

et al. The PBs then are the boundaries within which it is safe to affect the processes and thereby the ecosystems and global life-supporting systems. This is why this study is included in this literature review.

In the 2015 update of the PBs concept, the boundaries were defined more precisely and climate change and biosphere integrity have been denominated as core boundaries; each biophysical process interacts with other ones, but climate change and biosphere integrity interact with all other biophysical processes. Transgressing a core boundary will lead by itself to new states of the ES whereas transgressing any of the other boundaries doesn't, although this makes it more likely that other biophysical processes with which they interact transgress their boundary (Steffen, et al. 2015, 8).

The PBs concept elaborates on the sustainability characteristic "limited resilience of the biosphere to human activity" identified in paragraph 3.1.1 by identifying the biophysical processes which are affected by human activity and, more importantly, shed light on the limits of their resilience to human activity.

3.2 Sustainability characteristics

From the literature review, it seems that sustainability is often described as being based on the three pillars of social, environmental and economic sustainability. An additional pillar that is sometimes used, is organisational sustainability: organisation is needed to govern the other three pillars. Some definitions of sustainability refer to two, others to three or four of the pillars. Furthermore, in many definitions sustainability is characterised as a development or a process in society and that this development should be secured over the long term. Therefore, it is concluded that the most important characteristics that were identified in the literature review are the four pillars and the characteristics "process" and "long-term". The other characteristics that were identified characterise the four pillars: they either form themes within those pillars, sometimes also sub-themes or describe the goals or principles belonging to those pillars. This structure of sustainability pillars, main characteristics, themes and sub-themes is shown in figure 2.

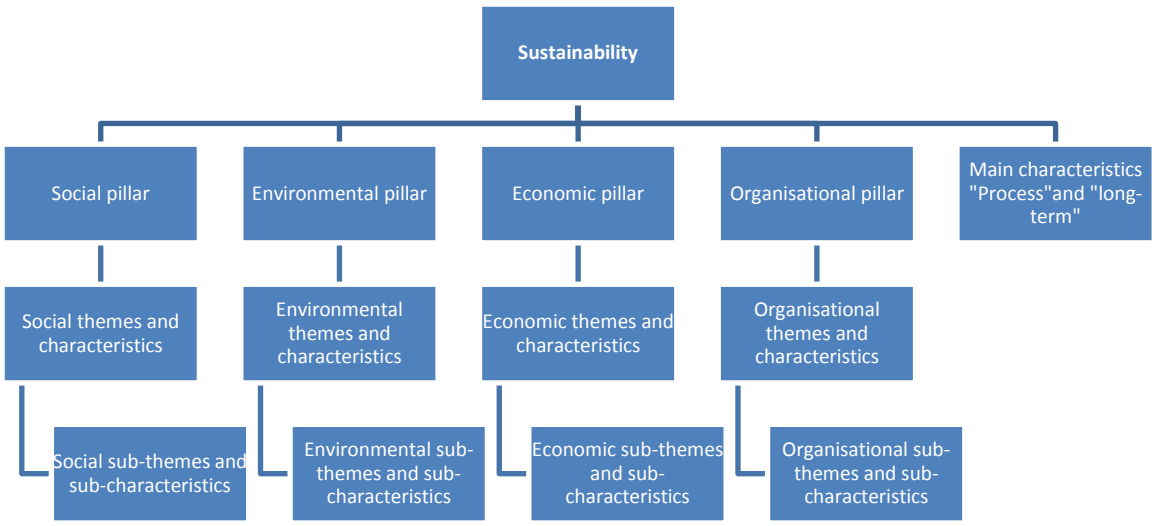

Figure 2 Sustainability scheme. Source: figure by author

In table 6 the same scheme can be found as in figure 2. The characteristics identified in the literature review are filled in in the pillar they characterise: either in the column of "themes/characteristics" or in the column "sub-themes/sub-characteristics. The characteristics "process" and "long-term" can be

found below the pillars. After each characteristic, the sources that use them in their sustainability definition are listed. Different formulations of the same characteristic have been used by different sources. The formulation of the WCED is used in table 6 in most cases, because this is where the characteristic has been found first. Characteristics that are not applied in the definition of the WCED have been formulated using the most fitting term used by one of the sources which name them.

Table 6 Sustainability scheme with sustainability characteristics

	Sustainability pillars and main characteristics	**Sustainability themes/characteristics**	**Sub-themes/sub-characteristics**
Sustainability	Social pillar	Meeting human needs (WCED 1987), (Moldan, Janousková and Hák 2012)	No poverty, zero hunger, good health and wellbeing, gender equality, quality education, clean water and sanitation, affordable and clean energy, reduced inequalities and access to justice. (UN DESA 3 n.d.), shelter and cultural expression (Moldan, Janousková and Hák 2012)
		Not compromising others to meet their needs (WCED 1987)	
		Prioritising the essential needs of the poor (WCED 1987)	
	Environmental pillar	Limited environmental resources (WCED 1987)	Renewable and non-renewable natural resources, regeneration, substitutability and assimilation (Moldan, Janousková and Hák 2012)
		Limited resilience of the biosphere to human activity (WCED 1987)	PBs: Climate change (UN DESA 3 n.d.), novel entities, stratospheric ozone depletion, atmospheric aerosol loading, ocean acidification, biogeochemical flows, freshwater use, land system-change and biosphere integrity (Steffen, et al. 2015)
		Staying within the potential of ecosystems (WCED 1987), (Moldan, Janousková and Hák 2012)	Conserve and sustainably use the oceans, seas and marine resources, combat desertification and halt and reverse land degradation and biodiversity loss (UN DESA 3 n.d.), provisioning, regulatory, cultural and supporting services (MEA 2005)
		Improving/maintaining the integrity of life supporting systems (Moldan, Janousková and Hák 2012)	Biodiversity and the biogeochemical integrity of the biosphere (Moldan, Janousková and Hák 2012), the stratospheric ozone layer, the climatic system, the hydrological cycle, the global biogeochemical cycles, goods provided by the geosphere, the three-dimensional open space. (Moldan, Janousková and Hák 2012) Biophysical processes: Climate change, novel entities, stratospheric ozone depletion, atmospheric aerosol loading, ocean acidification, biogeochemical flows, freshwater use, land system-change and biosphere integrity (Steffen, et al. 2015)

	Sustainability pillars and main characteristics	Sustainability themes/characteristics	Sub-themes/sub-characteristics
	Environmental pillar	Avoiding irreversibility (Moldan, Janousková and Hák 2012), (Steffen, et al. 2015)	
	Economic pillar	Decent work (UN DESA 3 n.d.)	Incomes (Moldan, Janousková and Hák 2012)
		Economic growth with the purpose of increasing prosperity (UN DESA 3 n.d.), (Moldan, Janousková and Hák 2012)	
		Industry (UN DESA 3 n.d.)	
		Innovation (UN DESA 3 n.d.)	
		Infrastructure (UN DESA 3 n.d.)	
		Responsible consumption and production (UN DESA 3 n.d.)	
	Additional pillar: organisation of sustainability	Technology and social organisation to create a harmony between the social and environmental characteristics (WCED 1987)	Partnerships for the goals and institutions for SD (UN DESA 3 n.d.)
	Main characteristics	Long-term (WCED 1987), (Moldan, Janousková and Hák 2012)	
		Process (WCED 1987)	

A characteristic of sustainability that could not be depicted in table 6 is that many definitions connect two or more sustainability pillars in their definition. Table 7 shows which sources connect which pillars in their definition.

Table 7 Connections between sustainability pillars in sustainability definitions

Pillars	Sources which connect the pillars
Social and environmental	(WCED 1987), (Moldan, Janousková and Hák 2012)
Environmental and economic	(Moldan, Janousková and Hák 2012)
Social, environmental and economic	(Moldan, Janousková and Hák 2012)
Social, environmental and organisation	(WCED 1987)
Social, environmental economic and organisation	(UN DESA 3 n.d.)

Not all of the identified sustainability characteristics and themes (column four of table 6) are equal in the level at which they characterise sustainability. For instance, economic growth is about the economy as a whole, whereas industry, innovation and infrastructure are only about a part of the economy. The purpose of economic growth is to increase prosperity, which can be, but not necessarily is created in industry, advanced through innovation and supported by infrastructure. To formulate a sustainability definition, sustainability as a whole should be characterised. A definition should not go into details about specific parts of the pillars, but characterise them as a whole. Such a

definition describes what sustainability means as a whole. What it means however for a specific part of a pillar, e.g. industry, is open for interpretation.

To leave less room for interpretation, principles can be created. They can be seen as a guide for implementing the sustainability definition. Many sustainability characteristics in table 6 are already formulated in principles: e.g. not compromising others to meet their needs, staying within the carrying capacity of ecosystems and avoiding irreversibility. Principles can also be found in other sustainability definitions in the literature review.

The characteristics and themes that characterise the pillars as a whole are considered to be the following:
Social: human needs
Environmental: ecosystems, global life-supporting systems and the natural resource base
Economic: increasing prosperity within the carrying capacity of the environment
Organisational: institutions

3.3 Conclusion

Here, the first research question will be answered: how could sustainability be defined? This question is answered by formulating a new definition of sustainability and creating guiding principles for the definition.

3.3.1 Definition

For defining sustainability, the most important characteristics will be used: the characteristics for each of the pillars and the general characteristics “long-term” and “process”.

All the pillars will be connected to each other because this is done in most of the definitions in the literature research. The environment provides all that is needed to increase prosperity. In economic activity, income is generated and goods and services which are provided by the environment are processed into goods and services which increase prosperity. To make sure that the economy operates within the capacity of the environment and to make sure that it serves the purpose of increasing prosperity, institutions are needed.

As was noted in paragraph 3.1.3, sustainability describes the properties of a system. To make the new definition as general as possible, the global society is chosen as the system. The general sustainability characteristic “process” stems from the WCED, which used it to describe sustainable development. As a definition of sustainability is formed here and not of sustainable development, this characteristic is transformed into “dynamic condition within a system”.

The following definition brings together the characteristics of all pillars, connects these pillars and describes a dynamic condition in the global society over the long-term:

> Sustainability is a dynamic condition in the global society supported and maintained by suitable institutions at all levels in which the integrity of the environment i.e. ecosystems, global life-supporting systems and the natural resource base is respected so it can continue into the future to regenerate the services necessary for economic activity, which has the purpose to increase prosperity within the carrying capacity of the environment.

3.3.2 Principles

The principles should function as a guide to direct any action of actors in society such as individuals, groups, organisations, businesses and governments etc. so that their actions are in line with sustainability.

Some general principles and some more specific ones follow from the newly formed definition of sustainability. Looking at this definition, specific principles are needed for how the suitable institutions should maintain sustainability, how actors in society should approach the integrity of ecosystems, global life-supporting systems and the natural resource base, how economic growth should be shaped so that it serves the purpose of increasing prosperity while not undermining in any way the condition of sustainability. The integrity of ecosystems and global life-supporting systems are both dependent on staying within the PBs. Therefore, the principles for these are the same.

General principles

1. Use environmental goods and services in such a way which does not eliminate or degrade or otherwise compromise the capacity of the environment to regenerate them;
2. Precautionary principle: take a precautionary approach when an action is uncertain to cause harm to the environment or to take away the possibility of people to meet their needs;

Principles for institutions

3. Provide an integrative framework addressing all sustainability aspects to support all actors in society to contribute to sustainability and discourage them to do the opposite;

Principles for the integrity of ecosystems and global life-supporting systems

4. Keep within the Planetary Boundaries;
5. Avoid irreversible consequences;

Principles for the integrity of the natural resource base

6. Extract resources in such a way which does not harm the natural system which provides them;
7. Extract renewable resources in such a way and in such amounts that the providing ecosystem is conserved;
8. Use up non-renewable resources in the rate at which renewable substitutes are developed;

Principles for economic activity

9. Produce goods and services which are needed to increase prosperity;
10. Do not compromise people to meet their needs;
11. Work according to the principles for the integrity of the environment i.e. principles 4-8.

4. Sustainability themes and sub-themes for sustainable supplier selection at the food sector of the StuWe

In this chapter, sustainability themes and sub-themes will be examined. In paragraph 4.1, the most important sustainability themes and sub-themes will be identified and the themes and sub-themes that are relevant for sustainable supplier selection at the food sector of the StuWe will be determined. In paragraph 4.2, the relevant sub-themes will be described and goals and indicators will be formulated. The relative importance of the sub-themes will be determined in paragraph 4.3.

4.1 Themes

Here, the second research question will be answered: what themes and sub-themes should a sustainability matrix for sustainable supplier selection at the food sector of the StuWe consist of? It is important to note that this question is answered in the context of the StuWe, which performs economic activity. The sustainability definition was set up for the global society.

Now the definition needs to be interpreted to examine what it means for supplier selection at the food sector of the StuWe. For economic activity, it is important to increase prosperity, while respecting the integrity of the environment, i.e. ecosystems, global life-supporting systems and the natural resource base. Therefore, human needs, ecosystems, global life-supporting systems and the natural resource base can be seen as the main themes for the matrix. These themes correspond to the most important characteristics and themes of the social and environmental pillars which were determined at the end of paragraph 3.2.

In the paragraphs 4.1.1-4.1.3, for each theme it will be examined which sub-themes belong to the themes looking at the sub-themes and sub-characteristics in table 6. The relevance of the sub-themes to potential suppliers of the StuWe will be discussed, followed by a selection of the relevant sub-themes. The sub-theme is considered relevant when the supplier directly affects it.

4.1.1 Human needs

Human needs were further specified with the sub-characteristics in table 6: no poverty, zero hunger, good health and wellbeing, gender equality, quality education, clean water and sanitation, affordable and clean energy, reduced inequalities and access to justice, shelter and cultural expression.

According to the sustainability definition and principle 9 (page 17), in economic activity, goods and services should be produced which meet those needs. Following principle 10, it should not compromise people to meet those needs. Potential suppliers of the StuWe play a part in meeting the nutritional need, therefore they already follow the definition. Following principle 10, they should do their business in such a way that it does not compromise others to meet any of their needs.

The potential suppliers do not directly affect all of those needs. The following needs are directly affected: no poverty because a business provides incomes, good health because the health of employees is influenced by working conditions, gender equality and reduced inequalities because a business can practice equal treatment in regards to recruitment and equal payment for equal work. Goal ten of the SDGS, reduced inequalities, is further described on the SDGs' website, indicating which inequalities are meant: "Goal 10 calls for reducing inequalities in income as well as those based on age, sex, disability, race, ethnicity, origin, religion or economic or other status within a country" (UN DESA 4 n.d.). There is however European legislation which is transposed into national law by EU Member States which guarantees minimum requirements for occupational safety and health (OSH) and makes discrimination based on gender, ethnic origin, religion or belief, disability, age and sexual orientation illegal:

- Council Directive 89/391/EEC - OSH "Framework Directive" of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work [1989] OJ L 183, 29.6.1989. This directive gives employers the duty to ensure the health and safety of its employees in every aspect related to work (Council Directive 89/391/EEC 1989, art. 5) and specifies this duty in article 6 of the directive;

- Council Directive 2000/43/EC of 29 June 2000 implementing the principle of equal treatment between persons irrespective of racial or ethnic origin [2000] OJ L 180, 19.7.2000. This directive regulates among others the conditions for access to employment as well as working conditions and pay (Council Directive 2000/43/EC , art. 3);

- Council Directive 2000/78/EC of 27 November 2000 establishing a general framework for equal treatment in employment and occupation [2000] OJ L 303, 2.12.2000. The purpose of this directive is to combat discrimination in regards to employment due to religion or belief, disability, age or sexual orientation (Council Directive 2000/78/EC , art. 1);

- Directive 2002/73/EC of the European Parliament and of the Council of 23 September 2002 amending Council Directive 76/207/EEC on the implementation of the principle of equal treatment for men and women as regards access to employment, vocational training and promotion, and working conditions [2002] OJ L 269, 5.10.2002. This directive regulates among others the conditions for access to employment as well as working conditions and pay (Directive 2002/73/EC, art. 3).

These directives are transposed into national law by most EU Member States: Council Directive 89/391/EEC is not transposed by Ireland, Cyprus and Malta (Eur-Lex 4 n.d.). Council Directive 2000/43/EC is not transposed by Ireland (EUR-Lex 1 n.d.). Council Directive 2000/78/EC is transposed by all EU Member States (Eur-Lex 2 n.d.). Directive 2002/73/EC is not transposed by Croatia (Eur-Lex 3 n.d.). Most potential suppliers of the StuWe are situated in Germany. As the European Directives apply on almost all of the potential suppliers of the StuWe, there is no need to make health, gender equality and reduced inequalities sub-themes for the matrix. Thereby, only poverty remains as a sub-theme for the matrix. As the wages the potential suppliers pay to their employees should be enough to keep them out of poverty, enough to make a living, this sub-theme is called “living wage”.

4.1.2 Integrity of ecosystems and global life-supporting systems

In order to respect the integrity of ecosystems and global life-supporting systems, the PBs of the biophysical processes should not be crossed. This is also reflected in principle 4. Therefore, the biophysical processes are in principle chosen as the sub-themes of this theme. Potential suppliers do not directly affect all of the sub-themes. Below, the relevance of each of the sub-themes to potential suppliers is discussed.

Climate change

Climate change is mainly caused by greenhouse gas emissions (GHGE), which, for a large part, are the result of using fossil fuels as energy sources. Through energy use, every supplier has GHGE, therefore directly contribute to climate change.

Novel entities

In the PB study, novel entities are defined as new substances, new forms of existing substances and modified life forms that have the potential for unwanted geophysical and/or biological effects (Steffen, et al. 2015, 7). “New” is explained as meaning new to the ES. Examples are chemicals and other types of engineered materials. Also naturally occurring substances, e.g. heavy metals, which are mobilised through human activity are considered to be novel entities. As every supplier uses novel entities, they directly affect this sub-theme.

Stratospheric ozone depletion
As the vast majority of ozone depleting substances has been phased out in the Montreal Protocol (Ozone Secretariat 2016), the importance of suppliers addressing this process is lifted. Therefore, this will not be a sub-theme.

Atmospheric aerosol loading
The most important sources of aerosols are the use of fossil fuels as energy sources, diesel transportation and cooking and heating with biofuels (Steffen, et al. 2015, 7). These are also important sources of GHGE that contribute to climate change. Therefore, there is no need make aerosols a separate sub-theme.

Ocean acidification
Due to the increased carbon dioxide (CO_2) concentration in the atmosphere, the oceans dissolve more CO_2 that then leads to ocean acidification (Rockström, et al. 2009, 10-11). As CO_2 is also a greenhouse gas (GHG), through addressing climate change, suppliers also address ocean acidification. Therefore, there is no need to make this an extra sub-theme of the matrix.

Biogeochemical flows, P and N
These flows are mainly altered by the use of fertilisers in agriculture (Steffen, et al. 2015, 8). Therefore, this sub-theme is only relevant for potential suppliers that perform agricultural activity, not for all other suppliers. Therefore, this sub-theme is a part of the matrix, but it does not need to be considered for potential suppliers that do not perform agricultural activity. This sets this sub-theme apart from the other sub-themes, as the others are always relevant for potential suppliers.

Freshwater use
In the PB study (Steffen, et al. 2015, 7), boundaries are set for the rate of water withdrawal along rivers and for the global total water withdrawal from rivers, lakes, water reservoirs and groundwater for industrial, agricultural and domestic use. The boundary for freshwater use from rivers is set based on the requirement of water by flow-dependant ecosystems. The boundary for global total freshwater use is set based on how much water is needed for moisture feedback to regenerate precipitation and for terrestrial and aquatic ecosystems (Rockström, et al. 2009, 16). All potential suppliers use freshwater, therefore, they directly affect this sub-theme. As freshwater is also a renewable resource, this can be covered under the theme “Resources”, so there is no need to make this an extra sub-theme.

Land-system change
Land-system change, the conversion of forests and other ecosystems into agricultural land, is globally mainly driven by agricultural expansion (Rockström, et al. 2009, 16-17). In Germany, where most potential suppliers are situated, there is a net loss of agricultural land instead of massive expansion (Umweltbundesamt 2014). Therefore, this sub-theme is considered not relevant for potential suppliers of the StuWe.

Biosphere integrity
The most important drivers of changes in biodiversity and ecosystems are habitat change (land use change and physical modification of rivers or water withdrawal from rivers), overexploitation of ecosystem services, the introduction of invasive alien species, pollution (mainly P and N) and climate change (MEA 2005, 67). Potential suppliers affect biodiversity when they expand their business on natural land and by the way they manage business premises. The name of this sub-theme is changed into biodiversity, because this is a more commonly used term and also the term “biodiversity loss” was used in the first publication on the PB’s study.

4.1.3 Integrity of the natural resource base

As was seen in paragraph 3.1.3, the natural resource can be divided into renewable and non-renewable natural resources. The International Resource Panel (IRP), launched by UNEP (IRP 1 n.d.), also calls renewable and non-renewable resources biotic and abiotic resources (IRP 2 n.d.). Examples of abiotic or non-renewable resources are fossil fuels, metals and minerals, examples of biotic or renewable resources are biomass, water, and land or more specifically: fisheries and forests (IRP 2 n.d.). As potential suppliers use both renewable and non-renewable resources, both make up the sub-themes of this theme.

4.2 Sub-themes

Each of the following paragraphs addresses one sub-theme. The paragraphs are structured as follows: first, the sub-theme is described. Second, the sustainability goal is derived from the description. Third, the indicators are formulated.

The indicators are built up in four levels of performance of the potential suppliers: green (3), yellow (2), orange (1) and red (0) where green is the most sustainable performance and red the least sustainable performance. When no information is provided, it is assumed that the sub-theme is not addressed at all. This demonstrates a level red performance. A grey level (0,5) is added for potential suppliers that do address the sub-theme but do not provide the required information on a sub-theme to assess the performance level. Each level corresponds with a number of points, with which the overall sustainability performance can be calculated and expressed in a number. This makes it easier to compare potential suppliers. This structure is illustrated in table 8.

Table 8 Structure of the goals and indicators of the sub-themes of the matrix

Goal	
Goal of the sub-theme	
Indicators	**Points**
The potential supplier demonstrates to have achieved the goal	3
The potential supplier demonstrates to have substantially achieved the goal *or* has taken some measures to reach the goal *and* has an action plan to achieve the goal and is implementing it	2
The potential supplier demonstrates to have taken some measures to make some progress on the goal *or* has an action plan to achieve some or substantial progress or to achieve the goal but is not implementing it yet	1
The potential supplier demonstrates to address the sub-theme but does not provide the necessary information to judge which level is reached	0,5
The potential supplier demonstrates to have taken no measures to make progress on the goal and has no action plan to make any progress to achieve the goal *or* does not provide any information about its actions on the sub-theme	0

For each sub-theme, the table is filled in with the goal of the sub-theme and definitions of the levels of the indicators. The levels are defined in such a way that they are clearly distinguishable and that the distance between each level is the same. This is reflected in the points that can be scored in each level. The grey level is another type of level. This level means that a potential supplier demonstrates to address a sub-theme, but with the provided information it is not possible to determine the level of performance. A score of 0,5 is granted, because by addressing the sub-theme, a performance higher than red is demonstrated, but it is unclear how much higher.

The StuWe currently bases its sustainability assessment of potential suppliers on their sustainability reports. The performance levels of the sub-theme form indicators that can help to assess the sustainability performance of potential suppliers based on their sustainability reports. If the

sustainability report does not address a sub-theme or if more information on a sub-theme is needed, then additional documents can be requested from the potential supplier. If the information still does not suffice, the red or grey level applies.

4.2.1 Living wage

Description

A living wage is not to be confused with a minimum wage, which is a legal minimum wage set by governments, not necessarily taking into account the minimum wage needed to make a living. Therefore, minimum wages can fall short of a living wage.

The Ethical Trade Initiative (ETI) is an alliance of businesses, trade unions and non-governmental organisations that promote workers' rights (ETI n.d.). In its Base Code of labour practise (ETI 2014, 2) the ETI describes a living wage as one that is paid for a standard working week and is enough for meeting basic needs and providing some discretionary income. This can be in combination with benefits paid by the employer. An even more accurate definition is provided by Social Accountability International (SAI), an organisation promoting human rights at work (SAI 2014, 6):

> "The remuneration received for a standard work week by a worker in a particular place sufficient to afford a decent standard of living for the worker and her or his family. Elements of a decent standard of living include food, water, housing, education, health care, transport, clothing, and other essential needs including provision for unexpected events"

In the UK, a minimum income standard (MIS) is determined and revised yearly by the Centre for Research in Social Policy at Loughborough University (Loughborough University 1 n.d.). It is seen as the minimum social living standard in the UK and is defined as follows (Davis, et al. 2016, 4):

> "A minimum standard of living in the UK today includes, but is more than just, food, clothes and shelter. It is about having what you need in order to have the opportunities and choices necessary to participate in society"

In summary, Davis et al. (Davis, et al. 2016, 4) describe the way the MIS is determined as follows: groups of members of the public are consulted about what goods and services one needs in order to achieve an acceptable standard of living and experts are consulted on nutritional and other fields to make sure the goods and services are adequate. The determined basket of goods and services is then priced at different stores and suppliers after which the MIS is calculated.

The MIS is used for determining the cost of living which is used by the Resolution Foundation to calculate the Living Wage in the UK, which was set at £8.25 per hour (D'Arcy and Finch 2016, 6, 17). This hourly rate was set by calculating the Living Wage for different family types and then calculating a weighted average of these (D'Arcy and Finch 2016, 24). At an annual basis, the income required to reach the MIS, is £17.311 for a single adult, £37.812 for a couple with two children (two earners) and £35.507 for a single parent with one child (Davis, et al. 2016, 40).

Davis et al. compare the MIS to the national poverty line (60% of the median income) for several types of households: the MIS reaches of 59% of the median for coupled pensioners to 87% for single parents with one child (Davis, et al. 2016, 27). This shows that people living in the UK which live on the national poverty line, live above the level that is perceived of as the minimum standard of living.

In France, Ireland and Portugal, the MIS methodology developed at Loughborough University formed the basis for developing budget standards for French households, a minimum income standard for Ireland and budget standards for Portugal (Loughborough University 2 n.d.). To have a uniform

definition of a living wage for all EU countries, the 60% median equivalised disposable income level (after social transfers) is used, which is the at-risk-of-poverty-threshold in the EU (Eurostat 2017). The equivalised disposable income level is the total income of a household after tax and other deductions (Eurostat 2017). The at-risk-of-poverty-threshold of all European countries for 2015 are shown in table 9.

Table 9 The 60% median equivalised disposable income in European countries in 2015. Source: adapted from (Eurostat 2017)

Country	Single person (€)	Two adults with two children younger than 14 years (€)	Country	Single person (€)	Two adults with two children younger than 14 years (€)
Austria	13.956	29.308	Latvia	3.497	7.344
Belgium	12.993	27.285	Lithuania	3.108	6.527
Bulgaria	1.999	4.198	Luxembourg	21.162	44.441
Croatia	3.275	6.877	Malta	8.096	17.001
Cyprus	8.276	17.380	Netherlands	12.775	26.828
Czech Republic	4.454	9.353	Norway	24.890	52.269
Denmark	17.019	35.739	Poland	3.333	7.000
Estonia	4.733	9.940	Portugal	5.061	10.628
Finland	14.258	29.942	Romania	1.389	2.917
Former Yugoslav Republic of Macedonia	1.272	2.670	Serbia	1.526	3.205
France	12.849	26.983	Slovakia	4.158	8.732
Germany	12.401	26.041	Slovenia	7.399	15.538
Greece	4.512	9.475	Spain	8.011	16.823
Hungary	2.734	5.741	Sweden	15.984	33.567
Iceland	14.218	29.857	Switzerland	23.752	49.878
Ireland	13.013	27.327	United Kingdom	12.567	26.391
Italy	9.508	19.966			

In a study for the Institute for the Study of Labour (Marx, Marchal and Nolan 2012), the minimum wages in 21 European countries are compared to the at-risk-of-poverty-threshold. For single adults, the minimum wage is enough in half of the countries to live above the at-risk-of-poverty-threshold (Marx, Marchal and Nolan 2012, 10). For one-earner families with two children, the minimum wage is not enough in any country, for single parents with two children, the situation is slightly better, but income is still below the at-risk-of-poverty-threshold in most countries (Marx, Marchal and Nolan 2012, 11).

This shows that the minimum wage is often not enough to live above the at-risk-of-poverty-threshold and that this differs largely between single earners and earners with a family. Therefore, what might be a living wage for one employee may not be a living wage for another. This means that there cannot be one level of the living wage. On the other hand, the adequate level of the living wage cannot be determined for employees of all different family types. Therefore, in this study the 60% of the median equivalised disposable income level in each country for a family with two children is considered to be a living wage (the columns “Two adults with two children younger than 14 years” in table 9). It is acknowledged that this is more than a living wage for single adults and less than a living wage for families with more children.

These living wages are for full-time employment. For employees that have a part-time position, the wage should be proportionate to the wage for full-time employment.

The Wirtschafts- und sozialwissenschaftliches Institut (WSI) describes how wages tariffs are set: in Germany, and in most European countries, collective wage agreements for industrial sectors are negotiated between labour unions and employers' associations. It is common for companies that are not a member of an employers' association to pay the wages in the collective wage agreement for their industrial sector, but it is not always obligatory. It is obligatory when a collective wage agreement is declared as generally binding. (WSI n.d.)

The only information which the StuWe can come by to assess whether a living wage is paid or not, is whether or not potential suppliers pay wages set in the collective wage agreement of their industrial sector, if the wages are higher or lower than these or if the minimum wage is paid.

Only the collective wage agreements which are declared as generally binding are listed on the website of the German Federal Ministry for Labour and Social Affairs (FMLSA) (FMLSA 2017). These lists do not provide information on the wage levels. Therefore, the StuWe cannot check if the wage is higher or lower than the living wage. Thus, it cannot be determined exactly if a living wage is paid or not.

Goal

The goal is for potential suppliers to at least pay a living wage to all of their employees, which is set the at-risk-of-poverty threshold in the EU for families with two children, which is 60% of the median equivalised disposable income level.

Indicators

As the information which the StuWe can get on wages is insufficient to judge if a living wage is paid or not, assumptions have to be made and thereby the indicators for this sub-theme are imperfect. It is assumed that a wage higher than the wage from the collective wage agreement is at least a living wage. But it may also be the case that the wage from the collective wage agreement is at least the living wage. The different levels of performance are described in table 10.

Table 10 Goal and indicators for the sub-theme "Living wage"

Goal	
At least a living wage is paid to all employees, which is set at the at-risk-of-poverty threshold (60% of the median equivalised disposable income level) in the EU for families with two children	
Indicators	**Points**
The potential supplier demonstrates to pay wages higher than those in the collective wage agreement for the applicable industrial sector to all employees	3
The potential supplier demonstrates to pay at least the wages according to the collective wage agreement for the applicable industrial sector to all employees	2
The potential supplier demonstrates to pay at least the minimum wage or a lower wage than the wage from collective wage agreement for the applicable industrial sector to all employees	1
The potential supplier provides information on its wage policy but does not provide the necessary information to judge the level of performance	0,5
The potential supplier demonstrates not to pay at least the minimum wage to some of its employees or does not provide any information about its wage levels	0

4.2.2 Climate change

Description

The most important assessments of the science of climate change are regularly conducted by the Intergovernmental Panel on Climate Change (IPCC). The factsheet about the IPCC explains the work of the IPCC (IPCC 2013): The IPCC was founded by the World Meteorological Organisation and UNEP in 1988 with the task of regularly providing policymakers with assessments of the science of climate change, its impacts and future risks and adaptation and mitigation options. The IPCC does not conduct scientific research by itself but assesses the published literature on climate change. The assessments are written by thousands of scientists and undergo several drafts and reviews before being published, which ensures that the full range of views from the scientific community is reflected. The authors of the assessments are divided into three working groups: Working Group I: the Physical Science Basis; Working Group II: Impacts, Adaptation and Vulnerability; Working Group III: Mitigation of Climate Change. Each Working Group produces one report, of which the main findings are combined in a Synthesis Report. The four reports combined are called Assessment Report (AR).

In the Synthesis Report of the latest AR (IPCC 2014), the latest scientific insights on the causes and impacts of climate change are presented: it is extremely likely that the anthropogenic GHGE, most notably CO_2, methane (CH_4) and nitrous oxide (N_2O), are the dominant cause of climate change, among other anthropogenic drivers (IPCC 2014, 4). Impacts of climate change on natural and human systems can already be seen on all continents and across all oceans (IPCC 2014, 6). Impacts on natural systems include changes in precipitation and ice melt, impacting water resources in quantity and quality and shifting the geographic range and abundance of species, among others. Impacts on human systems include impacts on health and food production, where the negative impacts on crop yields are more common than the positive impacts on crop yields (IPCC 2014, 6-7). Furthermore, the occurrence of extreme weather events has increased (IPCC 2014, 7), such as extreme warm temperatures, extreme sea levels and extreme precipitation events. The occurrence of extremely low temperatures has decreased.

Future risks and impacts include species extinction for a large fraction of species, large risks for food security, freshwater availability in sub-tropical regions and an increase in ill-health in many regions (IPCC 2014, 13, 15). Urban areas face increased risks for people, economies and ecosystems from extreme weather events and rural areas will face major impacts on freshwater availability, food security and loss of agricultural income. Aggregate economic losses increase with increasing temperature, but global economic impacts are hard to estimate. It is projected that the displacement of people will be increased. Climate change can indirectly increase risks of violent conflicts by amplifying drivers of these such as poverty and economic shocks (IPCC 2014, 16). For a temperature increase of 1.6 °C, risks of extreme weather events are high, and some ecosystems and cultures already at risk will face severe impacts (IPCC 2014, 72). Under a scenario in which GHGE are unabated, temperatures are likely to increase by 3.2 – 5.4 °C by the end of this century (IPCC 2014, 10). A temperature increase of 2 °C would negatively impact production of wheat, rice and maize in tropical and temperate regions, a temperature increase of 4 °C would pose large risks to food security globally (IPCC 2014, 13).

In December 2015 in Paris, 195 countries adopted a global climate deal, which is called the Paris Agreement (European Commission 2017). In article 2 of the agreement, the goal is formulated to hold the global average temperature increase to well below 2 °C above pre-industrial levels, with the aim of keeping the temperature increase below 1.5 °C (UN 2015).

In the Synthesis Report of (IPCC 2014), probabilities are calculated for staying below 1.5, 2 or 3 °C for several scenarios of cumulative CO_2 emissions (IPCC 2014, 64). If additional emissions of CO_2 from 2011 onwards stay below 400 gigatonnes (Gt), a 66% chance remains to stay under 1.5 °C warming,

whereby the goal formulated in the Paris Agreement would be reached. The Carbon Brief, a UK-based website that publishes about the latest developments in climate science and policy (Carbon Brief Ltd n.d.), has used the calculations of the Synthesis Report to calculate how many years are left until cumulative CO_2 emissions reach the different scenarios for different levels of warming. This is shown in figure 3.

To have a 66% chance of staying below 1.5 °C of warming, in only four years the emissions would have to stop completely. To have a 66% chance of staying below 2 °C of warming, current emission levels can continue for another 19 years and then drop to zero instantly. A more realistic scenario would be to cut emissions year by year until they are eliminated completely.

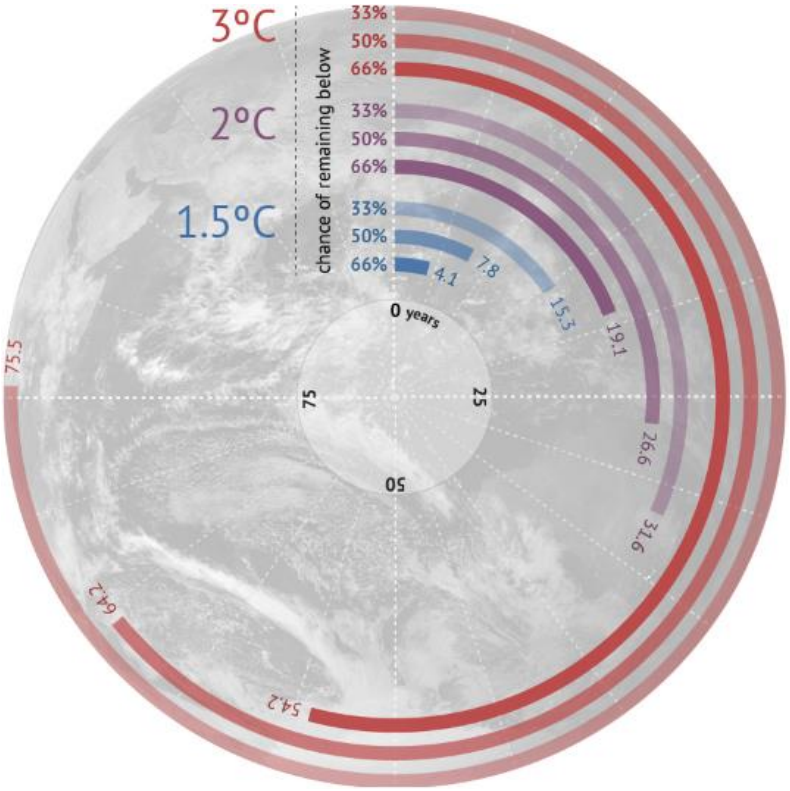

Figure 3 Carbon Countdown: as of the start of 2017, how many years of emissions would use up the IPCC's carbon budgets for different levels of warming? Source: (Carbon Brief Ltd 2017)

In the PB study, Steffen et al. have defined a boundary for climate change using the concentration of CO_2 in the atmosphere. As described in paragraph 3.1.4, the boundary indicates what is still a safe level of change for the biophysical processes, for which the boundaries have been set. Then an uncertainty zone is defined, that shows that it is not known exactly at which point negative effects occur. Beyond the zone of uncertainty lie thresholds that, when crossed, lead to changes in the ES with potentially devastating impacts on society. For climate change, the boundary has been set at a concentration of 350 parts per million (ppm) CO_2 and the zone of uncertainty reaches up until 450 ppm CO_2 (Steffen, et al. 2015, 4). As of January 2017, the CO_2 concentration was 405 ppm (Global Greenhouse Gas Reference Network 2017). In 2015 and 2016, the concentration rose by 3 ppm, in the years between 2000 and 2014, the concentration rose by 1-2 ppm per year (Global Greenhouse Gas Reference Network 2017). If the trend of 3 ppm per year of 2015 and 2016 continues, the concentration will have reached 417 ppm in four years, when, according to the calculations of the Carbon Brief, enough CO_2 will have been emitted to warm the Earth by 1.5 °C. This lies within the uncertainty zone as defined in the PB study.

Goal

The goal for this sub-theme follows the goal of the Paris Agreement, i.e. to limit warming to well below 2 °C and aiming for 1.5 °C. According to figure 3, to have a 66% chance to stay below 1.5 °C, current GHGE levels can continue for four years. As it is not possible to eliminate all emissions in an instant, emission reductions should start as soon as possible and emissions should be eliminated after ten years, i.e. in 2027. If emissions cannot be eliminated, they should be fully compensated.

Indicators

To achieve the goal, potential suppliers should identify the sources of their GHGE, then develop an action plan to eliminate or fully compensate these within a ten-year timeframe and implement it. Some potential suppliers may not have identified the sources of GHGE, but have identified the sources of (fossil fuel based) energy use and take measures to reduce (fossil fuel based) energy use. As fossil fuel based energy use is a big source or may even be the only source of the GHGE of potential suppliers, this demonstrates a level yellow performance on this sub-theme. All the different levels of performance on this sub-theme are shown in table 11.

Table 11 Goal and indicators for the sub-theme "Climate change"

Goal	
Elimination or full compensation of all GHGE within ten years i.e. by 2027	
Indicators	**Points**
The potential supplier demonstrates to have an action plan to eliminate or fully compensate all its GHGE within ten years' time.	3
The potential supplier demonstrates to have identified the sources of GHGE or fossil fuel based energy use, to have taken measures which substantially reduce these *or* demonstrates to have taken some measures to do so *and* has an action plan to reduce its GHGE or fossil fuel based energy use substantially but not within ten years and is implementing the action plan	2
The potential supplier demonstrates to have taken some measures to reduce GHGE or fossil fuel based energy use *or* has an action plan to identify the sources of its GHGE or fossil fuel based energy use and to reduce GHGE or fossil fuel based energy use but is not implementing it yet	1
The potential supplier demonstrates to address climate change in some way but does not provide the necessary information to judge the level of performance	0,5
The potential supplier demonstrates to have taken no measures to reduce GHGE or fossil fuel based energy use and has no action plan to do so *or* no information is provided on the actions on climate change	0

4.2.3 Novel entities

Description

As mentioned before, novel entities are new substances, new forms of existing substances and modified life forms that have the potential for unwanted geophysical and/or biological effects (Steffen, et al. 2015, 7). The effects of novel entities can be classified into two categories: firstly, they can affect the health of organisms and thereby ultimately affect ecosystem functioning and secondly, they can affect the other biophysical processes for which PBs have been set (Rockström, et al. 2009, 18). An example of the latter effect are chlorofluorocarbons (CFCs): although very useful, these had the unexpected effect to thin the ozone layer, which filters ultraviolet radiation from the Sun. Effects of novel entities on organisms include the hindrance of the development, the disruption of endocrine systems, the impediment of reproduction, mutations, neurobehavioral deficits and compromised immune systems (Rockström, et al. 2009, 19).

There are over a 100 000 novel entities in use of which only for a few thousand of these substances, toxicity data exist and hardly anything is known about the combined effects of these substances (Rockström, et al. 2009, 18). Because there are so many novel entities, Rockström et al. have not been able to neither set a boundary nor formulate a control variable, nor could this task be completed in the 2015 update of the PBs. Nevertheless, Steffen et al. point out that novel entities pose a potential threat to disrupt vital ES processes and therefore it is essential that society finds an approach to prevent those effects (Steffen, et al. 2015, 8).

Goal

Even though Steffen et al. have not been able to set a boundary for this sub-theme, it is clear that the goal for potential suppliers should be to reduce as much as possible the emissions and waste production of substances that are known to be harmful to the environment or of which it is unclear if they may have harmful effects on the environment.

Indicators

To reach this goal, potential suppliers should identify which novel entities they emit and produce waste of, which of these are proven to be harmful to the environment and of which ones the effects on the environment are unknown and take as many feasible measures as possible to reduce these emissions and the production of such waste. The different levels of sustainability performance on this sub-theme are shown in Table 12.

Table 12 Goal and indicators for the sub-theme "Novel entities"

Goal	
Reduction of emissions and waste production of substances which are harmful to the environment and of substances of which the effects on the environment are unknown as much as possible	
Indicators	**Points**
The potential supplier demonstrates to have identified the emissions and waste production of substances which are harmful and of which the effects on the environment are unknown and demonstrates to have taken as many measures as possible to reduce these emissions and production of such waste	3
The potential supplier demonstrates to have identified the emissions and waste production of harmful substances and to have taken measures which substantially reduce these emissions and waste production of harmful substances *or* has taken some measures *and* has an action plan to reduce the emissions and waste production of harmful substances or also possibly harmful substances as much as possible and is implementing it	2
The potential supplier demonstrates to have taken some measures to reduce the emissions and waste production of harmful substances *or* has an action plan to reduce the emissions and waste production of harmful substances or also possibly harmful substances as much as possible but is not implementing it yet	1
The potential supplier demonstrates to address novel entities in some way but does not provide the necessary information to judge the level of performance	0,5
The potential supplier demonstrates to have taken no measures to reduce the emissions of harmful substances and has no action plan to do so or possibly harmful substances *or* does not provide any information on its actions on novel entities	0

4.2.4 Biogeochemical flows: phosphorus and nitrogen cycles

Before this sub-theme is described, it should be mentioned that this sub-theme differs from the other sub-themes in that it is not relevant for potential suppliers, namely not for those that do not perform agricultural activity and that therefore, this sub-theme is not always a part of the final

sustainability score calculation. The final score is the percentage of the actual score of the full score possible. If this sub-theme is relevant, then the full score possible is higher and the actual score can be higher as well. As the final sustainability score is expressed in a percentage, potential suppliers for which this sub-theme is relevant are comparable to those for which this sub-theme is not relevant. An extra indicator level is added for this sub-theme, called “not applicable” (N/A). Instead of points, the score “N/A” is given. If a potential supplier does not perform agricultural activity, this sub-theme is not relevant and the level N/A applies. For potential suppliers that do perform agricultural activity, one of the other levels applies.

Description

The biogeochemical flow of P is altered through the mining of P in mineral form and using it as a fertiliser (Rockström, et al. 2009, 13). A second way the P flow is altered, is the use of manure as fertiliser (MacDonald, et al. 2011, 3086). The flow of N is mainly altered through industrial fixation of atmospheric nitrogen (N_2) into ammonia (NH_3) which is then used as a fertiliser and through N_2 fixation from leguminous crops (Rockström, et al. 2009, 13). Influxes of P and N into aquatic and marine systems cause, depending on the scale at which this occurs, eutrophication which can push water systems into a different stable eutrophic state (Rockström, et al. 2009, 12).

Steffen et al. have formulated the following PBs and control variables for P and N (Steffen, et al. 2015, 4): for P, a global boundary is set for the flow of P from freshwater into the ocean and a regional boundary of P from fertilisers to erodible soils. The global boundary is set at 11 Tera grams (Tg) P/year, where the current value is 22 Tg P/year. The regional boundary is set at 6.2 Tg P/year, where the current value is 14.2 Tg P/year. For N, a global boundary has been set for industrial and biological intentional N fixation from the atmosphere at 62 Tg N/year, where the current value is 150 Tg N/year. No regional boundary has been set. This demonstrates that this PB has already far been crossed. Steffen et al. indicate that there are areas with excess P and N and areas with P and N deficits. Limiting P and N use where it is in excess and increasing P and N use in regions with deficits could reduce the transgression of this boundary while at the same time boost food production in P and N deficient areas (Steffen, et al. 2015, 7).

Several attempts have been made to define local boundaries for P and N such as (Carpenter and Bennett 2011) and (De Vries, et al. 2013) as water eutrophication as a result of increased P and N fertiliser use occurs locally. Carpenter and Bennett have defined safe concentrations of P in surface waters: 24 mg P/m^3 in lakes and 160 mg P/m^3 in rivers (Carpenter and Bennett 2011, 4). De Vries et al. have defined safe concentrations for N in the atmosphere, surface waters and groundwater: 1-3 µm N/m^3, 1.0–2.5 mg N/l and N and 11.3 mg N/l respectively (De Vries, et al. 2013, 396).

These values are affected by the flows of P and N from agricultural land by run off into surface waters, leaching into groundwater and emissions into the atmosphere (EEA 2017) (Umweltbundesamt 2017). The total of these flows can be measured as the difference between P and N input on agricultural land as fertiliser and the output by harvesting and grazing. These are the so-called P and N balances, measured in kg P or N per hectare (ha) per year. (EEA 2017) If more P and N are applied on the land than is removed by harvesting or grazing, this surplus P and N ends up in the environment. The European Environment Agency (EEA) states that it is not trivial to define a sustainable nitrogen balance. Furthermore, the EEA states that a zero balance may not be realistic, but that the aim should be to reduce the balance to a minimum, by for instance more efficient agricultural practices. On average in the EU, the N balances declined from 63 kg N/ha/y in 2000 to 51 kg N/ha/y in 2013. Despite this decline, N flows into the environment still substantially exceed acceptable flows regarding safe levels in surface waters and the atmosphere (EEA 2017). This indicates that 51 kg N/ha/y is no safe N balance.

In Germany, the N surpluses declined from 117 kg N/ha/y in 1997 to 91 kg N/ha/y in 2014 (Umweltbundesamt 2017). From 2018 onwards, the maximum allowed N surplus will be 50 kg N/ha/y and the maximum allowed P surplus will be 10 kg P/ha/y according to the draft of the renewed Fertiliser Application Ordinance by the Federal Ministry of Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft, BMEL) (BMEL 2017, 17). This renewed act will enter into force in 2017 (Umweltbundesamt 2017). With the renewed act it will be mandatory for farmers to yearly report their P and N balances (BMEL 2017, 16).

The German Bund-Länder-Arbeitsgruppe zur Evaluierung der Düngeverordnung (BLAG) gave recommendations for the amendment of the Fertiliser Application Ordinance in a 2012 report (BLAG 2012). Some of the recommendations were made for P balances. The soil supply with P is often expressed in five classes: A-E, where class A means a low P supply, B moderate-low, C moderate, D moderate-high and E high (Csatho and Radimszky 2009, 1008). BLAG recommends the following P balances for each supply-class: A and B: a maximum of 60 kg P/ha/y, C: a maximum of 20 kg P/ha/y and for D and E the balance should be 0. Data on P supply-classes are however not available per farm (BLAG 2012, 44). The BLAG does not give recommendations for the N balance but rather gives recommendations for how the balance can be reduced by improved agricultural practices and technologies.

Goal

As the surplus P and N ends up in the environment, the goal for this sub-theme is to have no P surplus and to keep the N surplus as low as possible, at least below 10 kg N/ha/y. As stated by the EEA, a zero surplus for N is unrealistic, that is why the goal for the N surplus is set at 10 kg N/ha/y or lower and not at zero. The target P surplus is not defined per P supply-class because no data from potential suppliers will be available on those classes. If data were available, the goal for P would be set as recommended by BLAG for each supply-class, so there would be different goals for different supply classes. Now, the target P surplus for supply-classes D and E are taken as the goal for this sub-theme. It is acknowledged that this goal may not be realistic for potential suppliers with lower supply-classes. It should be pointed out that such suppliers have to keep their P surplus below 10 kg P/ha/y according to the draft Fertiliser Act, which is stricter than the recommendations by BLAG for supply-class C.

Indicators

For the potential suppliers that do not perform agricultural activity, the performance level N/A applies. For potential suppliers that do perform agricultural activity, one of the other levels applies.

As the renewed Fertiliser Application Ordinance will make it mandatory for farmers to report their P and N balances (which show the P and N surpluses or deficits), it will be easy to check whether the target surpluses are reached. For the same reason, the indicators are set up in four levels of P and N surpluses. Thereby, the indicators for this sub-theme are structured differently than for other sub-themes, as the others are based on what measures are taken to achieve the goal. For the other sub-themes, no numerical control variable could be formulated like the control variable kg P/ha/y and kg N/ha/y because of the nature of those sub-themes.

The target P and N surpluses as defined in the draft Fertiliser Ordinance are chosen as the orange level of performance because no points should be scored when the potential supplier does not comply with the law. The different levels of sustainability performance on this sub-theme are shown in Table 13.

Table 13 Goal and indicators for the sub-theme "Biogeochemical flows: P and N"

Goal	
No P surplus and a N surplus below 10 kg N/ha/y	
Indicators	**Points**
The biogeochemical flows of P and N are only directly influenced by potential suppliers which perform agricultural activity, therefore this level applies to all potential suppliers who do not perform agricultural activity	N/A
The potential supplier demonstrates to have no P surplus and to keep its N surplus below 10 kg N/ha/y	3
The potential supplier demonstrates to keep its P surplus below 5 kg P/ha/y and its N surplus below 30 kg N/ha/y	2
The potential supplier demonstrates to keep its P surplus below 10 kg P/ha/y and its N surplus below 50 kg N/ha/y	1
The potential supplier demonstrates to address P and N surpluses but does not provide the necessary information to judge if the orange, yellow or green level is reached	0,5
The potential supplier demonstrates to have a P surplus of 10 kg P/ha/y or more and a N surplus of 50 kg N/ha/y or more	0

4.2.5 Biodiversity

Description

There are several ways in which biodiversity is defined: in the PBs update of 2015, Steffen et al. refer to two types of biodiversity: genetically unique material, which gives the biosphere the capacity to persist under and adapt abiotic change and the diversity of functional traits of the organisms present in an ecosystem or biota (Steffen, et al. 2015, 5). As there is no information available on a global scale for genetically unique material, Steffen et al. use species richness as an interim control variable. Mace et al. write that biodiversity is usually understood as species richness, but also functional or ecosystem diversity or the whole variety of life on Earth (Mace, et al. 2014, 290). Mace et al. stress that it is not biodiversity but rather the extent and biomass of the biosphere, which is key for Earth System processes and ecosystems.

The PB of biodiversity loss is set at 10-100 times the natural rate of biodiversity loss, where the current rate of biodiversity loss is 100-1000 times the natural rate (Steffen, et al. 2015, 4). This shows that the PB has already been crossed and shows how much uncertainty remains about the rate of biodiversity loss as well as what a safe boundary would be.

The MEA names the most important drivers of changes in biodiversity and ecosystems: habitat change (land use change and physical modification of rivers or water withdrawal from rivers), overexploitation of ecosystem services, the introduction of invasive alien species, pollution production (mainly P and N) and climate change (MEA 2005, 67). The MEA further indicates what the most important drivers of change for several ecosystems are: for terrestrial ecosystems, this is land conversion to croplands and changed management practices and technologies used, for marine ecosystems this is fishing, which in some cases poses an example of overexploitation of ecosystem services. For freshwater ecosystems, the modification of water regimes, such as building reservoirs, the introduction of non-native invasive species and pollution (mainly P and N but also mining and pollution from cities) are the cause of change. Climate change has, among other impacts, lead to changes in species distribution, population size and increased disease and pest outbreak.

This translates into the following impacts from potential suppliers on biodiversity loss: the expansion of business premises on natural habitats, pollution and waste production, GHGE, changing business premises by soil sealing or excessive fertiliser use in agriculture. Ways potential suppliers can address these drivers are for example expanding their premises only in already urbanised areas, cutting

pollution and GHGE, restoring premises where possible to the naturally occurring habitat and reducing fertiliser use to levels that are not harmful to the environment. Potential suppliers could also compensate for expanding their business on natural habitats or for sealing their premises by restoring land to a natural state elsewhere. Restoring land to a natural state can take generations according to the World Resources Institute (World Resources Institute n.d.). Therefore, expanding business on natural land and restoring land elsewhere is not as good as expanding business in an already urbanised area and not restoring land elsewhere.

The action or inaction on climate change and fertiliser use is already covered under the sub-themes "climate change" and "biogeochemical flows: P and N" and pollution and waste production are already covered under the sub-theme "novel entities". Therefore, these should not be considered when assessing the level of performance on biodiversity.

Goal

The goal for this sub-theme is for potential suppliers to stop contributing to biodiversity loss by halting business expansion on natural land and restoring premises where possible to the naturally occurring habitat.

Indicators

To reach this goal, potential suppliers should explicitly decide to not expand the business on natural land, investigate how their premises could be restored to a natural state where possible, make an action plan to do so and implement it. The different levels of sustainability performance on this sub-theme are shown in Table 14.

Table 14 Goal and indicators for the sub-theme "Biodiversity"

Goal	
No contribution to biodiversity loss by committing to halt business expansion on natural land and restoring premises where possible to the naturally occurring habitat	
Indicators	**Points**
The potential supplier demonstrates to have committed to halt business expansion on natural land and to have restored premises where possible to the naturally occurring habitat	3
The potential supplier demonstrates to have committed to halt business expansion on natural land *and* to have taken measures to make premises more natural *or* has an action plan to restore premises where possible to the naturally occurring habitat and is implementing it	2
The potential supplier demonstrates to have committed to halt business expansion on natural land *or* to have taken some measures to make premises more natural or has restored land to its natural state elsewhere *or* has an action plan to make premises more natural or to restore land but is not implementing it yet	1
The potential supplier demonstrates to address biodiversity in some way but does not provide the necessary information to judge the level of performance	0,5
The potential supplier demonstrates to have taken no measures to stop contributing to biodiversity loss and has no action plan to do so *or* does not provide any information about its actions on biodiversity	0

4.2.6 Non-renewable resources

Description

As was mentioned in paragraph 4.1.3, non-renewable resources include fossil fuels, metals and minerals (IRP 2 n.d.). These in turn include all the materials made from those non-renewable resources such as plastics, fossil fuel based energy sources and construction minerals. Fossil fuel

based energy sources are not considered for this sub-theme as they are a key aspect for the sub-theme “climate change”. In paragraph 3.3.2, two principles were formulated for non-renewable resources:

- Extract resources in such a way which does not harm the natural system which provides them;
- Use up non-renewable resources in the rate at which renewable substitutes are developed.

Potential suppliers of the StuWe are unlikely to extract resources themselves; rather the resources they use have entered their supply chain in an early stage. Therefore, the first principle does not apply. As non-renewable resources are used by many actors, it is impossible for a potential supplier to determine how much of a non-renewable resource it can sustainably use. However, each use of non-renewable resources does contribute to non-renewable resource depletion. Therefore, potential suppliers should aim to reduce their non-renewable resource use as much as possible.

The IRP differentiates between primary material resources and secondary material resources. Primary material resources are for example ores, coal, minerals, metals, etc. whereas secondary materials have already been recycled and reused (IRP 2 n.d.). The second principle thus indicates that the use of primary material resources should be reduced whereas it is sustainable to use secondary material resources, given that those are recycled and reused entirely at the end of their lifespan.

Goal

The goal for this sub-theme is for potential suppliers to reduce the use of primary non-renewable resources as much as possible.

Indicators

Potential suppliers can reduce their use of primary non-renewable resources by reducing the material intensity of their products and services, recycling and reusing primary non-renewable resources or substituting them by renewable resources, whereby those substitutes need to be sustainable. Sustainable renewable resources are defined in paragraph 4.1.7.

The IRP defines Material Flow Analysis (MFA) as a group of methods to analyse the physical flows of materials into, through and out of a given system (IRP 2 n.d.). An MFA for non-renewable resources should be the starting point for potential suppliers that address their use of primary non-renewable resources. An MFA should show which primary non-renewable resources are used the most and where they are used. With the results of the MFA, the potential for reductions in the use of primary non-renewable resources or options for recycling and reusing can be identified and an action plan can be set up and implemented. The different levels of sustainability performance on this sub-theme are shown in Table 15.

Table 15 Goal and indicators for the sub-theme "Non-renewable resources"

Goal	
Reduction of the use of primary non-renewable resources as much as possible	
Indicators	**Points**
The potential supplier demonstrates to have conducted a Material Flow Analysis on the non-renewable resources it uses and to have taken action to reduce its use of primary non-renewable resources as much as possible	3
The potential supplier demonstrates to have conducted a Material Flow Analysis on the non-renewable resources it uses and to have taken action to substantially reduce its use of primary non-renewable resources *or* has an action plan to reduce its use of primary non-renewable resources *and* is implementing it	2
The potential supplier demonstrates to have taken some measures to reduce the use of primary non-renewable resources *or* has an action plan to achieve some or substantial reduction of its primary non-renewable resource use but is not implementing it yet	1
The potential supplier demonstrate to address primary non-renewable resources in some way but does not provide the necessary information to judge the level of performance	0,5
The potential supplier demonstrates to have taken no measures to reduce its use of primary non-renewable resources and has no action plan to make any progress to do so *or* does not provide any information about its actions on primary non-renewable resources	0

4.2.7 Renewable resources

Description

As already mentioned in paragraph 4.1.3, examples of biotic or renewable resources are biomass, water, and land or more specifically: fisheries and forests (IRP 2 n.d.). Renewable resources used by potential suppliers also include materials made from renewable resources such as paper and bioplastics. The use of biogas and renewable energy sources contribute to limiting GHGE and therefore to limiting climate change, therefore these are not considered here but under the sub-theme "climate change".

In paragraph 3.3.2, one principle was formulated about renewable resources: "extract renewable resources in such a way and in such amounts that the providing ecosystem is conserved". As renewable resources are used by many actors, it is impossible for a potential supplier to determine how much of a renewable resource it can use without compromising the providing ecosystems. However, each use of renewable resources limits the availability of renewable resources. Therefore, potential suppliers should aim to reduce their renewable resource use as much as possible, by reducing the material intensity of their products and services, reusing renewable resources and use recycled renewable resources. The renewable resources that are used, should come from sources that are managed according to the principle. Such sources are considered to be sustainable sources. Renewable resources from sustainable sources then are sustainable renewable resources.

Goal

The goal for potential suppliers is to limit their use of renewable resources as much as possible and to meet the remaining demand for renewable resources with sustainable renewable resources.

Indicators

As was the case for non-renewable resources, an MFA, as described in paragraph 4.2.6, should be the starting point for potential suppliers that address their use of renewable resources. An MFA should show that renewable resources are used the most and where they are used. With the results of the MFA, the potential for reductions in the use of renewable resources can be identified and an action plan can be set up and implemented. Furthermore, an investigation should be conducted to find

sustainable renewable resources to replace the renewable resources used. The different levels of sustainability performance on this sub-theme are shown in Table 16.

Table 16 Goal and indicators for the sub-theme "Renewable resources"

Goal	
Reduction of the use of renewable resources as much as possible and to meet the remaining demand for renewable resources where possible with sustainable renewable resources i.e. renewable resources from sources which are managed in such a way that the providing ecosystem is conserved	
Indicators	**Points**
The potential supplier demonstrates to have conducted a Material Flow Analysis (MFA) on the renewable resources it uses and to have taken action to reduce its use of renewable resources as much as possible and to meet its remaining demand for renewable resources where possible with sustainable renewable resources	3
The potential supplier demonstrates to have conducted a MFA on the renewable resources it uses and to have taken action to substantially reduce its use of renewable resources and to have switched to sustainable renewable resources where possible *or* has an action plan to do so *and* is implementing it	2
The potential supplier demonstrates to have taken some measures to reduce the use of renewable resources or to have (partially) switched to sustainable renewable resources *or* has an action plan to do so but is not implementing it yet	1
The potential supplier demonstrates to address renewable resources in some way but does not provide the necessary information to judge the level of performance	0,5
The potential supplier demonstrates to have taken no measures to reduce its use of renewable resources or to have switched to sustainable renewable resources and has no action plan to do so *or* does not provide any information about its actions on renewable resources	0

4.3 Relative importance of the sub-themes

In this paragraph, the relative importance of the sub-themes will be determined. The relative importance depends on the importance of the sub-themes and on the influence of potential suppliers on the sub-themes. The relative importance will be expressed in weighting factors. The weighting factor of a sub-theme is determined using the criteria in table 17. No matter how important a sub-theme may be, if a potential supplier has only a small influence on a sub-theme it is not so important to address the sub-theme. However, if the influence of potential suppliers on a sub-theme is given a higher weighting, then the difference in the weighting factors between sub-themes that are differently important, becomes smaller. Therefore, the weightings of the criteria are chosen in such a way that the importance of the sub-theme is twice as important as the influence of potential suppliers on the sub-theme.

Table 17 Criteria to determine the weighting factors of the sub-themes

Importance of sub-theme	Influence of potential suppliers on sub-theme
Direct impact of sub-theme on people: • Low (1) • Medium (2) • High (3)	Sub-theme is influenced: • Mainly earlier in the supply chain (2) • In the supply chain and by the potential supplier (4) • Mainly by the potential supplier (6)
Direct impact of sub-theme on the environment: • Low (1) • Medium (2) • High (3)	
Scale on which impacts occur: • Local (1) • Regional (2) • Global (3)	

Below, for each sub-theme the weighting factor is determined. The weighting factor is found in brackets behind each sub-theme.

Living wage (11):

- Direct impact of sub-theme on people: high (3)
- Direct impact of sub-theme on the environment: low (1)
- Scale on which impacts occur: local (1)
- Sub-theme is influenced: only by the potential supplier (6)

Climate change (12):

- Direct impact of sub-theme on people: medium (2)
- Direct impact of sub-theme on the environment: high (3)
- Scale on which impacts occur: global (3)
- Sub-theme is influenced: in the supply chain and by the potential supplier (4)

Novel entities (10):

- Direct impact of sub-theme on people: medium (2)
- Direct impact of sub-theme on the environment: medium (2)
- Scale on which impacts occur: local to global (2)
- Sub-theme is influenced: in the supply chain and by the potential supplier (4)

Biogeochemical flows, P and N (12):

- Direct impact of sub-theme on people: low (1)
- Direct impact of sub-theme on the environment: high (3)
- Scale on which impacts occur: local to regional (2)
- Sub-theme is influenced: Mainly by the potential supplier (6)

Biodiversity (8):

- Direct impact of sub-theme on people: low (1)
- Direct impact of sub-theme on the environment: high (3)
- Scale on which impacts occur: local to regional (2)
- Sub-theme is influenced: mainly earlier in the supply chain (2)

Non-renewable resources (8):

- Direct impact of sub-theme on people: low (1)
- Direct impact of sub-theme on the environment: medium (2)
- Scale on which impacts occur: local (1)
- Sub-theme is influenced: in the supply chain and by the potential supplier (4)

Renewable resources (9):

- Direct impact of sub-theme on people: low (1)
- Direct impact of sub-theme on the environment: high (3)
- Scale on which impacts occur: local (1)
- Sub-theme is influenced: in the supply chain and by the potential supplier (4)

4.4 Conclusion

Here, the following research questions are answered:

- Question 2: what themes and sub-themes should a sustainability matrix for sustainable supplier selection at the food sector of the StuWe consist of?
- Question 3: with what indicators could the sub-themes be measured and what should be the goals?
- Question 4: What is the relative importance of the sub-themes?

The themes, sub-themes, goals for the sub-themes and the relative importance of the sub-themes can be found in table 18. The relative importance is expressed by the weighting factor. The indicators of the sub-themes can be found at the end of the paragraphs of the sub-themes, i.e. paragraph 4.1.1-4.1.7.

Table 18 Themes, sub-themes, their goals and their relative importance

Themes	Sub-themes	Goals	Weighting factor
Human needs	Living wage	At least a living wage is paid to all employees, which is set at the at-risk-of-poverty threshold (60% of the median equivalised disposable income level) in the EU for families with two children	11
Integrity of ecosystems and life-supporting systems	Climate change	Elimination or full compensation of all GHGE within ten years i.e. by 2027	12
	Novel entities	Reduction of emissions and waste production of substances which are harmful to the environment and of which the effects on the environment are unknown as much as possible	10
	Biogeochemical flows: P and N	No P surplus and a N surplus below 10 kg N/ha/y	12
	Biodiversity	No contribution to biodiversity loss by committing to halt business expansion on natural land and restoring premises where possible to the naturally occurring habitat	8
Integrity of the natural resource base	Non-renewable resources	Reduction of the use of primary non-renewable resources as much as possible	8
	Renewable resources	Reduction of the use of renewable resources as much as possible and to meet the remaining demand for renewable resources where possible with sustainable renewable resources i.e. renewable resources from sources which are managed in such a way that the providing ecosystem is conserved	9

5. Matrix for sustainable supplier selection at the food sector of the StuWe

In this chapter, the final research question of this study is answered: how could a sustainability matrix be designed and used for sustainable supplier selection at the food sector of the StuWe? Paragraphs 5.1 and 5.2 answer the part of the question of how the matrix can be designed and paragraph 5.3 answers the part of the question of how the matrix can be used.

As described in paragraph 2.3, the matrix should meet the following criteria:

1. The matrix should serve as a support for the calculation tool for the sustainability score;
2. A title and sub-title should describe the purpose of the matrix;
3. The sustainability themes and sub-themes should be clear at a glance;
4. The goals and indicators should be portrayed;
5. The relative importance of the sub-themes should be portrayed;
6. The matrix should be in line with the definition of sustainability from part one.

In paragraph 5.1, the visual design of the matrix is presented. It is described how the last five criteria are met. Paragraph 5.2 explains how the matrix can be used to calculate the sustainability score of potential suppliers, which expresses the sustainability performance of potential suppliers in a percentage. This describes how the first criterion is met. In paragraph 5.3, a step by step guide is given for the calculation of the sustainability score. This describes how the matrix can be used for sustainable supplier selection at the food sector of the StuWe.

5.1 Matrix design

The matrix is presented in the box below. The title describes the purpose of the matrix. No sub-title is needed to elaborate the purpose. The themes are portrayed on the left side of the matrix in darkly-shaded colours. The corresponding sub-themes are portrayed in the middle and on the right in the same but lighter shaded colours. Below the names of the sub-themes the goals are written. The relative importance is expressed in a number in the lower right corner of each sub-theme.

The matrix is in line with the definition of sustainability of this study as the themes in the matrix are derived from the definition. Not all elements of the definition are found in the matrix because this is not necessary. The matrix nowhere contradicts the definition, rather: it elaborates on the definition by formulating goals for the sub-themes.

The indicators are left out of the matrix because there is no space for them in the matrix. Instead they are incorporated in the calculation tool described in the next paragraph.

Matrix for sustainable supplier selection at the food sector of the StuWe

Themes	Sub-themes The goal for potential suppliers for the sub-theme is written below the sub-theme. In the lower right corners of the sub-themes, their relative importance is expressed as a number.	
Human needs	**Living wage** At least a living wage is paid to all employees, which is set at the at-risk-of-poverty threshold (60% of the median equivalised disposable income level in the EU for families with two children) 11	
Integrity of ecosystems and global life-supporting systems	**Climate change** Elimination or full compensation of all GHGE within ten years i.e. by 2027 12	**Biogeochemical flows: Phosphorous and Nitrogen cycles** No P surplus and a N surplus below 10 kg N/ha/y 12
	Biodiversity No contribution to biodiversity loss by committing to halt business expansion on natural land and restoring premises where possible to the naturally occurring habitat 8	**Novel entities** Reduction of emissions and waste production of substances which are harmful to the environment and of which the effects on the environment are unknown as much as possible 10
Integrity of the natural resource base	**Renewable resources** Reduction of the use of renewable resources as much as possible and use of renewable resources where possible from sources which are managed in such a way that the providing ecosystem is conserved 9	**Non-renewable resources** Reduction of the use of primary non-renewable resources as much as possible 8

5.2 Sustainability score calculation

An Excel model is developed with which the sustainability score can be calculated: “Sustainability score calculation tool”. For this, only the score per sub-theme for each potential supplier needs to be filled in in the model. When all the scores of all sub-themes of all potential suppliers which are to be compared are filled in, the Excel model will display the sustainability score of the potential suppliers. Three calculations are made by the Excel model:

1. The score per sub-theme is calculated by multiplying the points scored with the weighting factor for that sub-theme which is displayed in the column “Score potential supplier 1”.
2. The maximum score possible is calculated by for all relevant sub-themes multiplying the points for the highest score possible, which is three, by the weighting factor of each sub-theme and then adding up all the points. This is displayed in the column “Maximum score possible by supplier 1”.
3. The sustainability score is calculated by dividing the score of a potential supplier by its maximum score possible. This score is displayed as a percentage next to the column “Sustainability score potential supplier 1”.

The sustainability scores of all sub-themes shows which potential supplier is the most sustainable supplier. The model also allows to easily compare potential suppliers on which sub-themes they score best: as the scores for the sub-themes are filled in, the fields take the colours of the score, i.e. green, yellow, orange, red, grey or white. The model is shown in figure 4 and can also be found in annex A. In figure 4, example fictitious scores of three potential suppliers are filled in to demonstrate what the model looks like when all scores are filled in and to make visible the final sustainability scores.

Sub-theme	Weighting factor	Maximum score possible = weighting factor × 3	Points per sub-theme potential supplier 1	Points per sub-theme potential supplier 2	Points per sub-theme potential supplier 3	Score potential supplier 1	Score potential supplier 2	Score potential supplier 3	Maximum score possible potential supplier 1	Maximum score possible potential supplier 2	Maximum score possible potential supplier 3
Living wage	11	33	3	2	1	33	22	11	33	33	33
Climate change	12	36	2	3	1	24	36	12	36	36	36
Novel entities	10	30	2	1	2	20	10	20	30	30	30
Biodiversity	8	24	0	1	2	0	8	16	24	24	24
Biogeochemical flows: P and N	12	36	N/A	2	1	0	24	12	-	36	36
Non-renewable resources	8	24	1	2	2	8	16	16	24	24	24
Renewable resources	9	27	1	1	2	9	9	18	27	27	27
Total		210				94	125	105	174	210	210

Sustainability score potential supplier 1	54%
Sustainability score potential supplier 2	60%
Sustainability score potential supplier 3	50%

Figure 4 Sustainability score calculation tool with example fictitious scores of potential suppliers

5.3 Step by step guide

This guide explains all the steps which need to be taken to select the most sustainable supplier for the food sector of the StuWe. It is assumed that a number of potential suppliers has been found which need to be compared on their sustainability performance. Below, all steps are described which lead to the sustainability scores of all potential suppliers which are to be compared.

Step 1 Request the sustainability report or other documents about the sustainability performance of all potential suppliers which are to be compared.

Step 2 Determine if the sub-theme “Biogeochemical flows: P and N” is relevant for the potential supplier. This sub-theme is only relevant when the potential supplier performs agricultural activity. Then check if the documents address all the relevant sub-themes. If a relevant sub-theme is not addressed, request additional documents that demonstrate how the sub-theme is addressed. If these are not provided, then the sustainability score for this sub-theme is 0.

Step 3 In the Excel model “Sustainability score calculation tool”, change the numbers of the potential suppliers into the names of the potential suppliers. This needs to be done in the fields “Points per sub-theme potential supplier 1-3”, “Score potential supplier 1-3”, “Maximum score possible potential supplier 1-3” and “Sustainability score potential supplier 1-3”.

Step 4 The sub-themes are listed in the first column of the calculation tool. If the cursor is moved over a sub-theme, a field appears which shows the goal and descriptions and points for the performance levels of the sub-theme. Compare the information on the sub-theme in the sustainability report of a potential supplier with the performance level descriptions of the sub-theme. Thereby, determine the performance level of the potential supplier and corresponding points. These points are filled in in the column “Score potential supplier 1-3”. When all the points for all potential suppliers are filled in, their sustainability scores will be displayed next to the fields “sustainability score

potential supplier 1-3”. Now, the most sustainable supplier can be selected. The potential suppliers can also be compared by the sub-themes as the fields of the sub-themes take the colour of the level when the score is filled in.

6. Example application of the matrix

Here, the sustainability score of an existing supplier of the StuWe is determined by following the step by step guide. For each step, it is explained what is done and what the result of that step is. Due to an arrangement of confidentiality, the supplier is kept anonymous. This supplier is referred to as "Supplier X".

Step 1

Request the sustainability report or other documents about the sustainability performance of all potential suppliers which are to be compared.
The StuWe has provided the sustainability report of Supplier X, and no further documents. The sustainability report is confidential.

Step 2

Determine if the sub-theme "Biogeochemical flows: P and N" is relevant for the potential supplier. This sub-theme is only relevant when the potential supplier performs agricultural activity. Then check if the documents address all the relevant sub-themes. If a relevant sub-theme is not addressed, request additional documents which demonstrate how the sub-theme is addressed. If these are not provided, then the sustainability score for this sub-theme is 0.
The sub-theme "biogeochemical flows: P and N" is not relevant because Supplier X does not perform agricultural activity. Below, for each sub-theme it is noted if it is addressed in the sustainability report and if the information is sufficient to judge the sustainability performance.
Living wage: no information on the wages of employees are provided in the sustainability report. Additional information is requested from the StuWe.

Climate change: this sub-theme is not explicitly addressed, but energy use is addressed, which is a very important issue for addressing climate change. Thereby, this sub-theme is indirectly addressed.

Novel entities: this sub-theme is not explicitly addressed, but waste is addressed which is likely to contain novel entities. Thereby, this sub-theme is indirectly addressed.

Biodiversity: biodiversity is not addressed.

Non-renewable resources: resources in general are addressed, thereby non-renewable resources are addressed.

Renewable resources: resources in general are addressed, thereby renewable resources are addressed.

Step 3

In the Excel model "Sustainability score calculation", change the numbers of the potential suppliers into the names of the potential suppliers. This needs to be done in the fields "Points per sub-theme potential supplier 1-3", "Score potential supplier 1-3", "Maximum score possible potential supplier 1-3" and "Sustainability score potential supplier 1-3".
In the Excel model in the document "Sustainability score calculation Supplier X", "potential supplier 1" is substituted by "Supplier X" in the fields mentioned above.

Step 4

The sub-themes are listed in the first column of the Excel Model. If the cursor is moved over a sub-theme, a field appears which shows the goal and descriptions and points for the performance levels of the sub-theme. Compare the information on the sub-theme in the sustainability report of a potential supplier with the performance level descriptions of the sub-theme. Thereby, determine the

performance level of the potential supplier and corresponding points. These points are filled in in the column "Score potential supplier 1-3". When all the points for all potential suppliers are filled in, their sustainability scores will be displayed next to the fields "sustainability score potential supplier 1-3". Now, the most sustainable supplier can be selected. The potential suppliers can also be compared by the sub-themes as the fields of the sub-themes take the colour of the level when the score is filled in.
Below, the sustainability performance level per sub-theme of Supplier X is discussed per sub-theme. The points which correspond with the performance level of Supplier X are filled in in the column "Score Supplier X".
Living wage: according to additional information the StuWe has provided, Supplier X has stated that it pays at least the wages from collective wage agreements to all of its employees and to some groups of employees even more. Therefore, Supplier X demonstrates a level yellow (2) performance.

Climate change: Supplier X has identified its sources of gas and electricity use and thereby an important part of its fossil fuel energy sources and has used this information in an action plan to take measures to substantially reduce gas and electricity use. Also a measure is taken to reduce the diesel use. All combined, Supplier X demonstrates a level yellow (2) performance in this sub-theme.

Novel entities: Supplier X has identified its waste production of hazardous and non-hazardous waste, but does not address novel entities explicitly. Hazardous waste is waste that is hazardous for human health and/or the environment (Umweltbundesamt 2014). Therefore, it may be assumed that this waste contains novel entities. Investments were made to improve wastewater treatment. Supplier X does not demonstrate to take any measures to reduce waste production, but the investment in wastewater treatment classifies as a measure to reduce waste production which may be hazardous to the environment. Therefore, it demonstrates a level orange (1) performance in this sub-theme.

Biogeochemical flows; P and N: this sub-theme is not relevant for Supplier X because it does not perform agricultural activity. Therefore, for this sub-theme Supplier X is performance level N/A.

Biodiversity: biodiversity is not addressed and Supplier X does not demonstrate to have committed to halt business expansion on natural land. Therefore, it demonstrates a level red (0) performance in this sub-theme.

Non-renewable resources: Supplier X explicitly addresses resources in its sustainability report, where it specifically addresses electricity, gas and water use and waste production. Electricity and gas use is covered under the sub-theme "Climate change", not under this sub-theme. Water use is covered under the sub-theme "Renewable resources". No mention is made of plastics, glass, metals or any other primary non-renewable resource nor is any recycling or reuse activity mentioned. Waste is categorised into hazardous and non-hazardous waste and waste from milk production, but no specification of the waste materials is given. Investments were made to improve the resource use efficiency, however it is not specified what resources are concerned and what the result of the investments is. Supplier X does not demonstrate to have conducted a MFA. The investment is the only measure taken to reduce the use of primary non-renewable resources. Therefore Supplier X performs level orange (1) for this sub-theme.

Renewable resources: the sustainability report only addresses water use. An overview is given of water use over the last eight years: in absolute numbers and in water use per unit of the end-product. Water use has increased, but water use per unit of end-product have decreased due to measures taken to reduce water use. Thereby, Supplier X demonstrates to have taken measures to reduce the use of renewable resources which is performance level orange (1).

All the scores of all the sub-themes as determined in step three have been filled in in the Excel model in the document “Sustainability score calculation Supplier X”. The sustainability score of Supplier X is 42%.

7. Conclusion

The objectives of this study were threefold: (1) to create insight into what sustainability means and come to a comprehensive definition of sustainability; (2) to identify the most important sustainability themes and sub-themes and their relative importance and the sub-themes which are relevant for potential suppliers of the StuWe and (3) to create a sustainability matrix with the relevant themes and sub-themes with goals and indicators which can be used for sustainable supplier selection at the food sector of the StuWe. As a result, the central question for this study was: how could sustainability be defined and how could a sustainability matrix of themes, indicators and goals be designed and used for sustainable supplier selection at the food sector of the StuWe? Here, this question will be answered.

The following definition of sustainability was set up, looking at the first definition of sustainability, the SDGs of the UN of 2015, definitions from the scientific community and the PBs concept which sets boundaries for the interference with nine key biophysical processes in the Earth System:

> Sustainability is a dynamic condition in the global society supported and maintained by suitable institutions at all levels in which the integrity of the environment i.e. ecosystems, global life-supporting systems and the natural resource base is respected so it can continue into the future to regenerate the services necessary for economic activity, which has the purpose to increase prosperity within the carrying capacity of the environment.

Accompanying the sustainability definition are the following principles, which should be seen as a guide to implement the definition by different actors in society such as individuals, groups, organisations, businesses and governments etc.:

General principles

1. Use environmental goods and services in such a way which does not eliminate or degrade or otherwise compromise the capacity of the environment to regenerate them;
2. Precautionary principle: take a precautionary approach when an action is uncertain to cause harm to the environment or to take away the possibility of people to meet their needs;

Principles for institutions

3. Provide an integrative framework addressing all sustainability aspects to support all actors in society to contribute to sustainability and discourage them to do the opposite;

Principles for the integrity of ecosystems and global life-supporting systems

4. Keep within the Planetary Boundaries;
5. Avoid irreversible consequences;

Principles for the integrity of the natural resource base

6. Extract resources in such a way which does not harm the natural system which provides them;
7. Extract renewable resources in such a way and in such amounts that the providing ecosystem is conserved;
8. Use up non-renewable resources in the rate at which renewable substitutes are developed;

Principles for economic activity

9. Produce goods and services which are needed to increase prosperity;
10. Do not compromise people to meet their needs;
11. Work according to the principles for the integrity of the environment i.e. principles 4-8.

From the sustainability definition, three overarching themes were identified that are relevant for potential suppliers of the StuWe: human needs, the integrity of ecosystems and global life-

Matrix for sustainable supplier selection at the food sector of the StuWe

Themes	Sub-themes The goal for potential suppliers for the sub-theme is written below the sub-theme. In the lower right corners of the sub-themes, their relative importance is expressed as a number.	
Human needs	**Living wage** At least a living wage is paid to all employees, which is set at the at-risk-of-poverty threshold (60% of the median equivalised disposable income level in the EU for families with two children) 11	
Integrity of ecosystems and global life-supporting systems	**Climate change** Elimination or full compensation of all GHGE within ten years i.e. by 2027 12	**Biogeochemical flows: Phosphorous and Nitrogen cycles** No P surplus and a N surplus below 10 kg N/ha/y 12
	Biodiversity No contribution to biodiversity loss by committing to halt business expansion on natural land and restoring premises where possible to the naturally occurring habitat 8	**Novel entities** Reduction of emissions and waste production of substances which are harmful to the environment and of which the effects on the environment are unknown as much as possible 10
Integrity of the natural resource base	**Renewable resources** Reduction of the use of renewable resources as much as possible and use of renewable resources where possible from sources which are managed in such a way that the providing ecosystem is conserved 9	**Non-renewable resources** Reduction of the use of primary non-renewable resources as much as possible 8

supporting systems and the integrity of the natural resource base. For each theme, a number of sub-themes was derived. Relevant sub-themes for potential suppliers of the StuWe were sorted from the sub-themes and selected for the sustainability matrix. For those sub-themes, goals and indicators were developed. The relative importance of those sub-themes was determined by looking at their impact on people and the environment, the scale on which the impacts occur and the influence potential suppliers have on the sub-themes. The relative importance is expressed in a weighting factor. With the themes, sub-themes and their relative importance, the sustainability matrix was created. Additionally, an Excel model was built to function as a tool to calculate the sustainability score of potential suppliers: “Sustainability score calculation tool”.

In the Sustainability score calculation tool, all sub-themes are listed along with their weighting factors. If the cursor is moved over the sub-themes, their goals and indicators are shown. The indicators are descriptions of four levels of sustainability performance reaching from zero to three. The level of performance can be determined looking at the sustainability report of the potential supplier. If the information in the sustainability report is insufficient to assess the level of performance, an additional level between zero and one applies. The levels of performance can be filled in beside the sub-themes, after which the sustainability score is calculated by the model.

8. Discussion

The title of this study is: “Defining sustainability and developing a matrix for sustainable supplier selection for Student Services Organisation Tübingen-Hohenheim”. In chapter five, a matrix was developed, but the Excel model “Sustainability score calculation tool” proved to be the tool with which the most sustainable supplier can be selected rather than the matrix. Nonetheless, the matrix gives a better overview of the themes and sub-themes and their goals and relative importance. The matrix does not contain the indicators of the sub-themes because there was no space for them. These are included in the sustainability score calculation tool. Thereby, the matrix and the calculation tool complement each other.

The overall study is very theoretical; a literature research lies at the basis from which a sustainability definition was created of which themes and sub-themes for the matrix were derived. Again based on further literature research, the sub-themes were elaborated and goals and indicators were set up. With these, the matrix and calculation tool were developed. They were not developed in cooperation with potential suppliers on which the matrix and calculation tool are to be applied. Rather, the matrix and calculation tool were tested afterwards on one supplier of the StuWe based on a sustainability report. The test was successful in that a sustainability score could be calculated for this supplier. But in cooperation with potential suppliers, more meaningful themes, sub-themes and indicators could be developed which better capture what potential suppliers do in the field of sustainability and measure progress to the goals and what they can and cannot do, or what market incentives or regulations stimulate potential suppliers to act unsustainably.

The test of the matrix and calculation tool also showed that the supplier does not explicitly address the sub-themes novel entities and biodiversity. If most potential suppliers do not explicitly address those sub-themes, then their scores for those sub-themes will be the same. Thereby, the difference in their sustainability score will come from fewer sub-themes. If the matrix and calculation tool are tested on more potential suppliers, then it will also become clear if the scores for other sub-themes is often the same.

As a result, two recommendations for further research can be made: firstly, the matrix and sustainability score calculation tool should be tested on the sustainability report of more potential suppliers of the StuWe. Secondly, with the test results and in cooperation with several potential suppliers, the matrix and calculation tool should be adjusted so that it they are not only based on theory but also applicable in practise.

Bibliography

BLAG. *Evaluierung der Düngeverordnung – Ergebnisse und Optionen zur Weiterentwicklung.* Braunschweig: BMEL, 2012. 44.

BMEL. "Draft Fertiliser Ordinance." *Verordnung zur Neuordnung der guten fachlichen Praxis beim Düngen.* Bundesministerium für Ernährung und Landwirtschaft, 15 February 2017: 16.

Carbon Brief Ltd. *About us.* n.d. https://www.carbonbrief.org/about-us (accessed April 14, 2017).

—. *Carbon Countdown.* 5 April 2017. https://www.carbonbrief.org/analysis-four-years-left-one-point-five-carbon-budget (accessed April 14, 2017).

Carpenter, S.R., and E.M. Bennett. "Reconsideration of the planetary boundary for phosphorus." *Environmental Research Letters*, 2011. 4, 8.

„Council Directive 2000/43/EC ." *Council Directive 2000/43/EC of 29 June 2000 implementing the principle of equal treatment between persons irrespective of racial or ethnic origin OJ L 180, 19.7.2000.* 2000.

„Council Directive 2000/78/EC ." *Council Directive 2000/78/EC of 27 November 2000 establishing a general framework for equal treatment in employment and occupation [2000] OJ L 303, 2.12.2000.* 2000.

„Council Directive 89/391/EEC." *Council Directive 89/391/EEC - OSH "Framework Directive" of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work [1989] OJ L 183, 29.6.1989.* 1989.

Csatho, P., and L. Radimszky. "Two Worlds within EU27: Sharp Contrasts in Organic and Mineral Nitrogen–Phosphorous Use, Nitrogen–Phosphorous Balances, and Soil Phosphorus Status: Widening and Deepening Gap between Western and Central Europe." *Communications in Soil Science and Plant Analysis*, 2009: 1004, 1015.

D'Arcy, C., and D. Finch. *Making the Living Wage The Resolution Foundation review of the Living Wage.* London: Resolution Foundation, 2016, 6.

Davis, A., K. Hill, D. Hirsch, en M. Padley. *A Minimum Income Standard for the UK in 2016.* York, UK: Joseph Rowntree Foundation, 2016, 4.

De Vries, W., J. Kros, C. Kroeze, and S.P. Seitzinger. "Assessing planetary and regional nitrogen boundaries related to food security and adverse environmental impacts." *Current opinion in environmental sustainability*, 2013: 396.

Deutsches Studentenwerk. *Studentenwerke.* n.d. https://www.studentenwerke.de/en/content/studentenwerke (accessed April 7, 2017).

„Directive 2002/73/EC." *Directive 2002/73/EC of the European Parliament and of the Council of 23 September 2002 amending Council Directive 76/207/EEC OJ L 269, 5.10.2002.* 2002.

EEA. *Agricultural land: nitrogen balance.* 24 February 2017. http://www.eea.europa.eu/airs/2016/natural-capital/agricultural-land-nitrogen-balance (accessed March 21, 2017).

ETI. *About ETI.* n.d. http://www.ethicaltrade.org/about-eti (accessed January 20, 2017).

—. "The ETI Base Code." *The ETI Base Code.* 1 April 2014. 2.

EUR-Lex 1. *National transposition.* n.d. http://eur-lex.europa.eu/legal-content/en/NIM/?uri=CELEX:32000L0043 (accessed April 29, 2017).

Eur-Lex 2. *National transposition.* n.d. http://eur-lex.europa.eu/legal-content/en/NIM/?uri=CELEX:32000L0078 (accessed April 29, 2017).

Eur-Lex 3. *National transposition.* n.d. http://eur-lex.europa.eu/legal-content/EN/NIM/?uri=celex:32002L0073 (accessed April 29, 2017).

Eur-Lex 4. *National transposition measures.* n.d. http://eur-lex.europa.eu/search.html?type=advanced&qid=1493555457445&DN=71989L0391*&DTS_SUBDOM=MNE (accessed May 1, 2017).

European Commission. *Climate Action .* 12 April 2017. https://ec.europa.eu/clima/policies/international/negotiations/paris_en (accessed April 14, 2017).

Eurostat. *At-risk-of-poverty thresholds - EU-SILC survey.* 28 March 2017. http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_li01&lang=en (accessed April 20, 2017).

—. *Glossary: Equivalised disposable income.* 6 February 2017. http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Equivalised_disposable_income (accessed April 20, 2017).

—. *Income Distribution Statistics.* 24 February 2017. http://ec.europa.eu/eurostat/statistics-explained/index.php/Income_distribution_statistics (accessed April 20, 2017).

FMLSA. *Allgemeinverbindliche Tarifverträge.* 1 January 2017. http://www.bmas.de/DE/Themen/Arbeitsrecht/Tarifvertraege/tarifvertraege.html (accessed May 2, 2017).

"General Anti-Discrimination Act of August 14th 2006 ." *General Anti-Discrimination Act of August 14th 2006 (Federal Law Gazette I, page 1897), last amended by Article 8 of the Act on 3rd Arpil 2013 (Federal Law Gazette I, page 610).* 2006.

Global Greenhouse Gas Reference Network. *Earth System Research Laboratory .* 5 April 2017. https://www.esrl.noaa.gov/gmd/ccgg/trends/global.html#global_data (accessed April 15, 2017).

IPCC. *Climate Change 2014: Contributions of Working Groups I, II and III to the fifth Assessment Report of the IPCC.* Synthesis Report, Geneva, Switzerland: IPCC, 2014, 4, 6, 7, 10, 13, 15, 16, 64, 72.

—. "IPCC Factsheet: what is the IPCC." *IPCC.* 30 August 2013. http://www.ipcc.ch/news_and_events/docs/factsheets/FS_what_ipcc.pdf (accessed April 17, 2017).

IRP 1. *About us.* n.d. http://www.resourcepanel.org/about-us (accessed April 5, 2017).

IRP 2. *Glossary.* n.d. http://www.resourcepanel.org/glossary (accessed April 5, 2017).

Jackson, T. *Prosperity without Growth.* London, UK: Earthscan, 2008. 3.

Lexikon der Nachhaltigkeit. *Weltkommission für Umwelt und Entwicklung (Brundtland Bericht | Brundtland Report).* 3 November 2015. https://www.nachhaltigkeit.info/artikel/brundtland_report_1987_728.htm (accessed June 29, 2016).

Loughborough University 1. *Minimum Income Standards.* n.d. http://www.lboro.ac.uk/research/crsp/mis/ (accessed March 14, 2017).

Loughborough University 2. *MIS in other countries.* n.d. http://www.lboro.ac.uk/research/crsp/mis/other_countries/ (accessed May 2, 2017).

MacDonald, G.K., E.M. Bennett, P.A. Potter, and N. Ramankutty. "Agronomic phosphorus imbalances across the world's croplands." *Proceedings of the National Academy of Sciences of the United States of America*, 2011: 3086.

Mace, G.M., et al. „Approaches to defining a planetary boundary for biodiversity." *Global Environmental Change*, 2014: 290.

Marx, I., S. Marchal, and B. Nolan. *Mind the Gap: Net Incomes of Minimum Wage Workers in the EU and the US.* Discussion Paper, Bonn, Germany: Institute for the Study of Labor , 2012. 10-11

MEA. *Ecosystems and Human Well-being: Synthesis.* Washington, DC.: Island Press, 2005. 40, 67.

Moldan, B., S. Janousková, and T. Hák. "How to understand and measure environmental sustainability: indicators and targets." *Ecological Indicators*, 2012: 4-7.

Ozone Secretariat. "Handbook for the Montreal Protocol on Substances that Deplete the Ozone Layer - Foreword." *Ozone Secretariat.* 2016. http://ozone.unep.org/en/handbook-montreal-protocol-substances-deplete-ozone-layer/2 (accessed November 7, 2016).

Rockström, J., et al. "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." *Ecology and Society*, 2009: 10-13, 16-19.

SAI. *Social Accountability 8000 International Standard.* International Labour Standard, New York, USA: SAI, 2014, 6.

Steffen, W., et al. “Planetary boundaries: Guiding human development on a changing planet.” *Science*, 2015: 1, 2, 4, 5, 7, 8.

Stockholm Resilience Centre. *Planetary boundaries - About the research.* n.d. http://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research.html (accessed August 9, 2016).

—. *Planetary Boundaries: a safe operating space for Humanity.* Stockholm Resilience Centre, n.d.

StuWe 1. *Mensa & Cafeteria - gestärkt in den Studienalltag.* 2016. http://www.my-stuwe.de/mensa/ (accessed November 18, 2016).

StuWe, 2, interview by M Baijens. (17 May 2016).

Umweltbundesamt. *Hazardous waste.* 18 March 2014. https://www.umweltbundesamt.de/en/topics/waste-resources/waste-management/waste-types/hazardous-waste (accessed February 13, 2017).

—. *Landbedeckung und Landnutzung.* 17 March 2014. https://www.umweltbundesamt.de/daten/bodenbelastung-land-oekosysteme/landbedeckung-landnutzung#textpart-4 (accessed March 6, 2017).

—. *Nährstoffeinträge aus der Landwirtschaft und Stickstoffüberschuss.* 7 February 2017. https://www.umweltbundesamt.de/daten/land-forstwirtschaft/landwirtschaft/naehrstoffeintraege-aus-der-landwirtschaft#textpart-1 (accessed March 21, 2017).

UN DESA 1. *Report of the World Commission on Environment and Development - Our Common Future.* n.d. https://sustainabledevelopment.un.org/milestones/wced (accessed June 29, 2016).

UN DESA 2. *Open Working Group on Sustainable Development Goals.* n.d. https://sustainabledevelopment.un.org/owg.html (accessed July 5, 2016).

UN DESA 3. *Sustainable Development Goals.* n.d. https://sustainabledevelopment.un.org/sdgs (accessed July 5, 2016).

UN DESA 4. *SUSTAINABLE DEVELOPMENT GOAL 10 Reduce inequality within and among countries.* n.d. https://sustainabledevelopment.un.org/sdg10 (accessed October 27, 2016).

UN OWG on SDGs. „Methods of Work.” 2013.

UN. “Paris Agreement.” UN Framework Convention on Climate Change, 2015.

WCED. „From One Earth to one World: Our Common Future.” UN, 1987. 16, 41

World Resources Institute. *Initiative 20x20.* n.d. http://www.wri.org/our-work/project/initiative-20x20/faqs#project-tabs (accessed May 4, 2017).

WSI. *So funktioniert das Tarifsystem.* n.d. https://www.boeckler.de/wsi-tarifarchiv_3396.htm (accessed April 26, 2017).

Annex A

Sustainability score calculation tool

Name of the document: Sustainability score calculation tool.xlsx

Sub-theme	Weighting factor	Maximum score possible = weighting factor × 3	Points per sub-theme potential supplier 1	Points per sub-theme potential supplier 2	Points per sub-theme potential supplier 3	Score potential supplier 1	Score potential supplier 2	Score potential supplier 3	Maximum score possible potential supplier 1	Maximum score possible potential supplier 2	Maximum score possible potential supplier 3
Living wage	11	33				0	0	0	33	33	33
Climate change	12	36				0	0	0	36	36	36
Novel entities	10	30				0	0	0	30	30	30
Biodiversity	8	24				0	0	0	24	24	24
Biogeochemical flows: P and N	12	36				0	0	0	36	36	36
Non-renewable resources	8	24				0	0	0	24	24	24
Renewable resources	9	27				0	0	0	27	27	27
Total		210				0	0	0	210	210	210

Sustainability score potential supplier 1	0%
Sustainability score potential supplier 2	0%
Sustainability score potential supplier 3	0%

Figure 5 Sustainability score calculation tool

Sub-theme	Weighting factor	Maximum score possible = weighting factor × 3	Points per sub-theme potential supplier 1	Points per sub-theme potential supplier 2	Points per sub-theme potential supplier 3	Score potential supplier 1	Score potential supplier 2	Score potential supplier 3	Maximum score possible potential supplier 1	Maximum score possible potential supplier 2	Maximum score possible potential supplier 3
Living wage	11	33				0	0	0	33	33	33
Climate change	12	36				0	0	0	36	36	36
Novel entities						0	0	0	30	30	30
Biodiversity						0	0	0	24	24	24
Biogeochemical flows: P and N						0	0	0	36	36	36
Non-renewable resources						0	0	0	24	24	24
Renewable resources						0	0	0	27	27	27
Total						0	0	0	210	210	210

Goal:
No contribution to biodiversity loss by committing to halt business expansion on natural land and restoring premises where possible to the naturally occurring habitat

Performance levels:
3: The potential supplier demonstrates to have committed to halt business expansion on natural land and to have restored premises where possible to the naturally occurring habitat

2: The potential supplier demonstrates to have committed to halt business expansion on natural land *and* to have taken measures to make premises more natural *or* has an action plan to restore premises where possible to the naturally occurring habitat and is implementing it

1: The potential supplier demonstrates to have committed to halt business expansion on natural land or to have taken some measures to make premises more natural or has restored land to its natural state elsewhere *or* has an action plan to make premises more natural or to restore land but is not implementing it yet

0,5: The potential supplier demonstrates to address biodiversity in some way but does not provide the necessary information to judge the level of performance

0: The potential supplier demonstrates to have taken no measures to stop contributing to biodiversity loss and has no action plan to do so or does not provide any information about its actions on biodiversity

Figure 6 Sustainability score calculation tool with the indicators of the sub-theme "Biodiversity"

Sub-theme	Weighting factor	Maximum score possible = weighting factor × 3	Points per sub-theme potential supplier 1	Points per sub-theme potential supplier 2	Points per sub-theme potential supplier 3	Score potential supplier 1	Score potential supplier 2	Score potential supplier 3	Maximum score possible potential supplier 1	Maximum score possible potential supplier 2	Maximum score possible potential supplier 3
Living wage	11	33	3	2	1	33	22	11	33	33	33
Climate change	12	36	2	3	1	24	36	12	36	36	36
Novel entities	10	30	2	1	2	20	10	20	30	30	30
Biodiversity	8	24	0	1	2	0	8	16	24	24	24
Biogeochemical flows: P and N	12	36	N/A	2	1	0	24	12	-	36	36
Non-renewable resources	8	24	1	2	2	8	16	16	24	24	24
Renewable resources	9	27	1	1	2	9	9	18	27	27	27
Total		210				94	125	105	174	210	210

Sustainability score potential supplier 1	54%
Sustainability score potential supplier 2	60%
Sustainability score potential supplier 3	50%

Figure 7 Sustainability score calculation tool with example fictitious scores