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Institute of Environmental and Sustainability Communication

Consumer perception of product carbon footprint labelling

A concept proposal

Scientific paper in fulfilment of the requirements

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Abstract

The aim of this paper is to determine how a carbon footprint label for grocery products can be designed to facilitate a sustainable consumption behaviour. Therefore, a mixed-method approach was used consisting out of a review of relevant literature and an explorative quantitative survey with n = 158 participants. It was found that consumers generally have a positive attitude towards carbon labelling, but they lack understanding of the term, its underlying concepts and the emissions caused by grocery products. In regard to the design criteria of a carbon label, labels with a coloured scale are preferred most by consumers. Also, the mechanisms of consumer behaviour imply that not all parts of the behaviour are visible and controllable for individuals themselves. The concluding concept proposal summarises important criteria of a carbon labelling system that has the goal to educate consumers and facilitate a lower carbon consumption behaviour, such as a simple visual design, the use of a colour scale, a design enabling a comparison, the provision of a link to further information, the public enforcement of the system and overall uniformity.

Keywords:

Carbon label

Design criteria

Consumer perception

Knowledge gaps

Consumer behaviour

1. Introduction

Climate change and global warming is one of the most pressuring and urgent problems that humankind is currently facing. The rise in global temperature causes more extreme weather conditions, threatens a large variety of species, leads to the rising sea level and other potentially irreversible damages to the planet. A major driver of it are the anthropogenic emissions of greenhouse gases (GHG) like carbon dioxide (CO_2), methane and nitrous oxide, often expressed in equivalents of CO_2 (CO_2e) (US EPA, 2015). The public is aware of the situation (Canavari & Coderoni, 2020) and although there are some, who doubt the existence of a human made climate change, the majority accepts the need to act against it. Therefore, a goal has been set by the Paris Agreement to limit the rise in temperature to a maximum of 1.5°C (European Comission, 2016). Furthermore, a significant reduction of GHG emissions by 2030 and the support of renewable energies is aspired. Despite different measures implemented by the international governments, this goal is likely to be missed (United Nations Environment Programme, 2019). For that reason, additional measures are necessary to be able to stay below the targeted mark and prevent an aftermath that is out of control for humankind.

Many policies so far have mainly targeted industries and producers (Vanclay et al., 2011). Heating, electricity use and transportation account for most of the emissions caused by humans (US EPA, 2016a). However, up to 14% of all anthropocentric emissions in Germany are caused by agricultural (WWF Germany, 2012). This can be expected to be even higher for the overall food consumption. Right now, most of the modern globalised societies are characterised by the demand for cheap products that are always available and the requirement for the choice of a great variety of items. In order to be able to stay ahead of the competition, producers boost their production to be faster, cheaper and to be capable of the largest possible output. Consequently, the market is oversaturated, millions of tons of products are wasted each year (United Nations Environment Programme, 2020) and most products are produced regardless of the emissions caused by them. Accordingly, a change of food consumption behaviour has the potential to reduce the emissions of greenhouse gases substantially. While some argue that a change to a diet with less meat or even a vegetarian or vegan diet is the most effective way to achieve that (Röös & Tjärnemo, 2011), others suggest that choices in favour of low carbon products within a product category have a greater effect (Wallén et al., 2004). Regardless of which one of those measures has the greater potential to lower emissions from food consumption, the behavioural change needs to be facilitated for consumers.

One possibility to enable consumer behaviour to become more sustainable is the implementation of product carbon footprint (PCF) labels that communicate the environmental impact of a product. At this point in time a variety of eco-labels already exists in Germany.

Examples are the Fairtrade label, the Bio label that indicates organic food, the Vegetarian label and many more (BUND, 2020; V-Label, 2016). However, information about the carbon footprint of a product can hardly be found, save for some exceptions like the company Oatly, that displays the carbon footprint on some of its products voluntarily (Oatly, 2020b). In the United Kingdom some efforts have been made by the retailer tesco to implement a product carbon footprint label, but the project was stopped in 2012 due to high costs and a lack of success (Environment + Energy Leader, 2012), and so far there is no widespread standardised label in any European country. One of the reasons why no concept has been introduced in a broader scale is the complexity of such an implementation. Depending on the institution responsible for the implementation, different goals can be set for a product carbon footprint label. Furthermore, the consumer perception of such a label is crucial for its success.

For that reason, carbon footprint labelling is subject to a lot of different research. It aims to answer questions like how the current state of the consumers' knowledge about carbon footprints in the food industry looks like, how consumers perceive different labels, how effective a product carbon footprint can be and a lot of others.

This paper applies a mixed-method approach in order to answer the following research question:

How can a product carbon footprint label be designed to facilitate consumer behaviour towards more sustainable buying decisions?

Three sub-questions were developed to complement the research question and answer it more precisely:

1. *What elements can help to make complex knowledge about product carbon footprints and life cycle assessments comprehensible for non-academic target groups and other target groups being unfamiliar with the terminology on the example of a product carbon footprint label?*
2. *What knowledge gaps do consumers have regarding product carbon footprints and life cycle assessments that need to be addressed by a product carbon footprint label?*
3. *What criteria must be met by a product carbon footprint label in order to be accepted by consumers in a way that it positively influences their buying behaviour?*

In order to answer those, a structured literature review is presented in this paper. In addition, an explorative survey with n=158 participants was carried out to substantiate the findings. Therefore, participants were asked to answer questions and rate statements to find out their environmental attitude and behaviour, their previous knowledge about product carbon

footprints and life cycle assessments (LCA), their design preferences and the conditions under which a label would influence their buying decisions.

This paper discusses the findings of the survey in regard to the literature reviewed to conclude in recommendations for the implementation of a product carbon footprint labelling system and to inspire future research. Different studies have come to the result, that consumers prefer labels that are simple in design, allowing a quick comparison while grocery shopping (Hartikainen et al., 2014; Röös & Tjärnemo, 2011). In addition, more information is needed for them to be able to grasp the meaning of a product carbon footprint label and to be able to make use of it. The more knowledge is available to consumers, the more they can get involved in the choices of different labelled products. For those reasons, a concept proposal of a design that combines multiple important aspects of a carbon footprint label is presented as a result of the findings.

2. Product carbon footprints and life cycle assessments

Product carbon footprints and life cycle assessments are a complex subject with a lot of different research going into it. In general, "[t]he product carbon footprint is a measure of the climate change impact of the product where all the greenhouse gas emissions emitted during the product life cycle are taken into account" (Hartikainen et al., 2014). In other words, the product carbon footprint describes the amount of greenhouse gas emissions that result from the entire life cycle of a product. The reference unit is usually CO_2, meaning that the equivalent for the impact of other greenhouse gases like methane is calculated and expressed in numbers of CO_2e (or CO_2eq).

In order to identify as many of the emissions caused by a product as possible, a life cycle assessment is a helpful method. Just like the different stages in the life-cycle of a butterfly (the egg, the larva, the caterpillar, the chrysalis and the butterfly), a product made by humans also has different stages in its life cycle (see Appendix 1, Figure 3). From obtaining everything needed to make the product, through manufacturing it, using it and finally deciding what happens to it after its usage, these different stages need to be included when calculating the emissions caused (Matthews et al., 2014). For example, during the production of beef the cattle needs to be fed. For their feed, the growing of plants requires fertilizer and water, both also sources of greenhouse gas emissions (Camilleri et al., 2019). The cattle itself releases methane, which is much more potent than CO_2 (US EPA, 2016b). This is only a small part of the entire production that needs to be regarded.

All products have different life cycles and each product has its own carbon footprint. Due to the complexity of their individual life cycles, the extend of such an assessment needs to be clearly communicated through the definition of the boundaries. The outcome of the life cycle

assessment depends on these system boundaries. Only then the results of the assessment can be compared and translated into valuable statements about a product. It is important to notice, that a life cycle assessment can never be perfectly executed. A large part of it relies on assumptions and benchmarks, for which no standard procedure is ruled out. Moreover, most of the times not all details can be worked out and not every required piece of information is available or accessible.

Since it is nearly impossible for consumers to know the life cycle of every product that they are buying let alone their emissions, product carbon footprint labelling aims to educate them about the product that they are buying and to help them make more informed decisions. Theoretically, these labels could be displayed on a product like e.g. a fair-trade label. It provides the consumer with information about the carbon footprint of a product and whether a product is more or less harmful for the environment than others.

3. Methodology

A mixed-method approach was chosen for this paper because a lot of research on carbon footprint labelling already exists. Yet, there is no conformity in the results. Hence, the literature review was conducted to summarise the relevant aspects from different sources in order to provide detailed insight for the research questions. The data from the survey is supposed to be used as additional support for the findings. The subsequent concept proposal uses the gathered knowledge to form the central contribution of this paper to this field of research.

3.1. Literature review

For the literature review an approach from Luederitz et al. (2016) was chosen, that advocates systematic student-driven literature reviews. Accordingly, the literature search engine LUX of the Leuphana University of Lueneburg was searched with the search string “product carbon footprint labelling”. From the 49 articles that were shown, results were excluded when they were a) not electronically available and b) not providing information about consumer related topics on product carbon footprint labelling, leaving 17 articles. Additional literature about product carbon footprint labelling and consumer behaviour from other database searches was added. The literature originates from different European countries and Australia. The results from the review were grouped into four topics.

3.2. Survey

A survey conducted in August 2020 was designed to complement the literature review and to provide further insights of consumer perception of product carbon footprint labelling in order to justify the concept proposal. The survey was created with LimeSurvey and consisted of six

different parts. For the complete structure view Appendix 2. For reasons of limited financial resources and limited time available for the conduction and evaluation, the survey was mostly quantitative with only two semi-open questions. The survey was distributed via a link to the website through different social media, the myStudy frontpage of the Leuphana University of Lueneburg, a messenger group exclusively for students of environmental science at the Leuphana University and social contacts. Therefore, it was assumed that most of the participants are students at the university. To attract more attention and increase the number of interested people, participants were offered a chance to win one of five gift cards, which were distributed after the survey ended. As the majority of participants was expected to be German the survey was translated into German. However, in order not to exclude international students or other participants not speaking German an English version of the survey was provided as well. As the survey collected a convenience sample, it is not representative for any population and needs to be regarded as an exploratory addition to the literature review.

The survey consisted of six parts with a total of 32 questions or statements and took approximately 10-15 minutes to complete. For the overview in this paper, the individual questions were coded with the number of the part and the number of the question respectively (e.g. P1Q1 for the first question of the first part). The first part included questions about demographical data about the participants such as their age group, gender, occupation and country of residence. The response format generated ordinal and nominal data. The second part asked the participants to respond to different statements about their environmental attitude and behaviour, such as: “The environmental performance of a product is an important criterion for me when shopping for groceries.” or “I changed my diet for environmental reasons (e.g. eating less meat or choosing a vegetarian/vegan diet).” Answers were given on a Likert scale from 1 (strongly disagree) to 5 (strongly agree), generating ordinal data. Question P2Q5 (“I think of myself as someone who is very concerned with environmental issues.”) was adapted from Hope et al. (2018). The third part aimed to test the participants’ prior knowledge about product carbon footprints and life cycle assessments. Therefore, they were asked if they a) know what an ecological footprint is, b) have calculated their ecological footprint, c) have heard of product carbon footprints before and d) have heard of life cycle assessments before. According to the questions they had to answer with yes or no. Furthermore, they were asked of their capability to describe the previous terms on a scale from 1 (can’t describe at all) to 5 (can describe perfectly). The participants then had to list a maximum of three factors that they thought contribute the most to the emissions caused by the production of grocery items. The fourth part aimed to find out the needs of consumers from a label in order to close knowledge gaps regarding product carbon footprints and life cycle assessments. For them to be able to evaluate the statements, the participants were provided with a short informational text about the subject. Afterwards, different statements about the communication of previously learned

information had to be evaluated on a scale from 1-5, e.g. “I think communication of this information is important for a product carbon footprint label to be useful.” The fifth part was designed to identify the preferences for design criteria concerning a product carbon footprint label. Again, the participants had to evaluate statements like “A visual guidance tool should be included (e.g. a colour code with red indicating more harmful products, yellow indicating moderately harmful product and green indicating the least harmful products)” on a scale from 1-5. Finally, the sixth part served the purpose of learning about consumers’ needs for incentives to buy lower carbon footprint products. It consisted of two statements to be evaluated on a scale from 1-5 and a question asking the participants to list a maximum of three conditions under which they would consider buying a product with a lower carbon footprint from two or more options.

For a clearly arranged presentation of the results and to enable the calculations of the statistical tests, the answers of the German speaking participants were translated into English and spelling errors were corrected. When some participants entered the state where they live in, the respective country of residence was inserted, instead. Set of answers were excluded from the survey, if the participants failed to complete it. Exceptions were made, when only a few answers were missing, and they were marked with no answer (NA). Since question P3Q8 (“Please list three factors that you think contribute the most to the emissions caused by grocery products. Try to use only one word for each answer.”) and question P6Q3 (“Under which conditions would you consider buying a product with a lower carbon footprint from two or more options? Please list three factors below. Try not to use more than three words for each answer.”) were not mandatory to answer, some more answers were marked NA here.

For testing the hypotheses of the survey, RStudio (Version 1.1.447) was used. When the Spearman’s rank correlation was calculated, only complete datasets were used. Therefore, pairs of variables were excluded when either one of them or both were marked NA. The survey was planned to be accessible for participants for the duration of two weeks but was ended earlier because it received more participation than anticipated. It was active for six days, before it was manually stopped.

4. Literature review

The summarised findings from the literature review are presented in the following section and divided into four topics. Since most of the research on carbon footprint labelling contributes to more than one of those attributes, results overlapping the categories are frequent. Nonetheless, they were assigned to one of the topics based on their main statements.

4.1. Knowledge gaps concerning product carbon footprint labelling

A majority of consumers seem to be aware of climate change and the necessity to act against it (Canavari & Coderoni, 2020). Furthermore, the term carbon footprint is familiar to many (Canavari & Coderoni, 2020; Thøgersen & Nielsen, 2016). Additionally, there is a growing demand for a labelling system that indicates the emissions caused by a product and consumers express a generally positive attitude towards it (Gadema & Oglethorpe, 2011; Upham et al., 2011).

However, most studies on consumer perception of carbon footprint labelling agree that consumers struggle to understand carbon labels and its underlying concepts once they are confronted with it. According to Canavari & Coderoni (2020) consumers find labels in itself complicated and have difficulties to understand them. Upham et al. (2011), as well as Thøgersen & Nielsen (2016) have found that without additional information the public found it difficult to grasp the emissions values of a labelled product. When asked to describe the term carbon footprint, participants of a study conducted by Hartikainen et al. (2014) failed to connect it to climate change, greenhouse gases or global warming. Also, they were not able to define it properly. Gadema & Oglethorpe (2011) state that “confusion in interpreting and understanding labels is correspondingly high at a total of 89%”. Although their study was conducted in a different sector of consumption, Gössling & Buckley (2016) conclude from their results that even if consumers are concerned about the impact of their actions on climate change, carbon labels are ineffective as long as they don’t overcome their deficiencies in communications. Otherwise there would be opportunities for a more widespread use of carbon labels (Gössling & Buckley, 2016).

Despite some consumers acknowledging that products with environmental labels can help to fight climate change (Canavari & Coderoni, 2020), the emissions of the food sector and the potentials for a reduction of emissions by altering food consumption habits are largely underestimated by many (Camilleri et al., 2019; Hartikainen et al., 2014). More specifically, consumers lack understanding of what factors of food have the highest contribution to their overall emissions. They often consider the packaging, transport and processing of a product to be the main sources of emissions (Hartikainen et al., 2014). This leaves out many other contributors like the primary production or the extraction of the raw material necessary for a product. As reported by Camilleri et al. (2019), “[p]eople tend to underestimate the energy consumed by and GHG emissions from the production, storage and transport of a range of foods.“ In a study, where participants were asked to guess the emissions of different products in reference to a 100-W incandescent bulb, the differences in magnitude of their answers was not representative for the actual emissions of the products (Camilleri et al., 2019). One reason for this might be the overestimation of people of their understanding of everyday objects. The

more complex they are, the more fragmentary and incomplete is the common knowledge about it, but it is largely unchallenged because people are seldom asked to explain these objects or processes. Therefore, they are often unaware of gaps in their understanding (Camilleri et al., 2019). This is underpinned by information asymmetries that exist between the consumers and the producers, explicitly regarding environmental concerns (Upham et al., 2011). As a result, companies can claim a high environmental performance of their products. These might either be genuine or targeted to employ a strategy of greenwashing, which is difficult to notice for consumers (Upham et al., 2011).

Hence, the implementation of a product carbon labelling system faces some significant challenges. For consumers to be able to make use of a label, they would need "a lot of background knowledge about typical carbon emissions in the product group or at least to compare the available product alternatives on offer on this dimension" (Thøgersen & Nielsen, 2016). Steiner et al. argue that sustainability labels are valuable for communicating important information to consumers, but also point out that a more targeted provision of information may be more effective. Finally, Gössling & Buckley (2016) emphasise that ecolabels provide technical knowledge in order to change a certain behaviour. For that reason, consumers are required to "understand that information, appreciate its significance, trust its reliability, and know how to act more sustainably" (Gössling & Buckley, 2016).

4.2. Consumer perception of product carbon footprint labelling

Attitudes are referred to as tendencies to act a certain way based on the experience of an individual and their temperament. This concept is often used while trying to make sense of a certain behaviour (Pickens, 2005). Perceptions, on the other hand, describe how people interpret and construct a sensation to form it into their own experience of their surroundings. This leads to the possibility that the perception of an individual is dissimilar compared to the reality (Pickens, 2005).

Although many consumers advocate product carbon footprint labelling, as the results of an Eurobarometer survey, according to which 72% of EU citizens want carbon footprint information on products to be mandatory, indicate (European Comission, 2009), existing labels are not considered to be very valuable. A study conducted in Spain found that participants valued the Protected Designation of Origin (PDO) label, organic and nutritional labels the most. Thøgersen & Nielsen (2016) discovered that participants of their study preferred organic to non-organic products and products certified by a public authority. Carbon footprint labelling together with food-miles labelling was among the least valued (de-Magistris et al., 2017). However, Canavari & Coderoni (2020) argue that a combination of different logos together with

a carbon footprint label makes the latter more effective. Too many labels on the other hand, may increase the risk of losing consumers' trust (Klockenhoff, 2009).
Generally, there are several determinants that indicate a more positive attitude towards carbon labelling. A higher degree of education and the environmental attitude of consumers are found to be significant here (de-Magistris et al., 2017). One possible explanation for this is the understanding of a carbon label being significantly higher, when the individual is more educated or more environmentally concerned. This is supported by the findings of Hartikainen et al. (2014), where participants generally expressed a positive attitude towards product carbon footprint labelling after they were provided with a correct definition of the product carbon footprint. Nevertheless, it was regarded as only one important criterion regarding climate change and people found it difficult to put the information into perspective with their current understanding. Therefore, an overall low expressed importance of information on the product carbon footprint was found (Hartikainen et al., 2014; Lampert et al., 2017). When the claims of a label are difficult for consumers to verify, they mistrust it more often (Groening et al., 2014).

The insufficient use of labels does not only apply to carbon labelling. European consumers are typically unaware of most food labels regarding genetically modified ingredients and they make little use of nutritional information, especially if it is considered to be complicated (Vanclay et al., 2011). A carbon footprint label is seen as important to have, but consumers don't read it to an extend where they process the information displayed (Canavari & Coderoni, 2020). According to Groening et al. (2014), most consumers will focus on the net emissions rather than trying to understand how different levels of emissions and measures to offset emissions effect the net outcome. Even though the public supports carbon labellig, mistrust in the effectiveness of emissions reduction and changing consumer behaviour, as well as mistrust in the motives of companies, negatively influences the consumer perception (Upham et al., 2011).

Therefore, several studies on consumer preferences indicate that publically enforced labels, e.g. labels regulated by the EU, are more valued than private labels (de-Magistris et al., 2017). Industry labels usually can not make use of an enforcement mechanism, which makes them less trustworthy. Labels enforced by the government "would have the authority to dictate uniformity and specificity across industries, states, and perhaps national borders" (Groening et al., 2014).

Yet another obstacle for achieving a significant level of change while relying on consumer choice is the difficulty to normalise and communicate carbon footprint information. Also, only a small proportion of consumers prioritise environmental purposes when shopping for groceries. This is especially the case when other attributes like taste and the perceived health benefits

dominate the decision process and a lower carbon product is not perceived as an equivalent substitute (Upham et al., 2011).

4.3. Design criteria of a product carbon footprint label

There are many different possible designs for carbon footprint labels and many of them have been used in carbon labelling schemes. Schaefer & Blanke (2014) have summarised 10 categories in which carbon labels have appeared worldwide: 1) labels with a total CO_2 value, 2) labels with a colour code, 3) labels that indicate a CO_2 reduction or conversion labels, 4) Climatop for Migros, Switzerland, 5) airfreight labels, 6) labels stating that a product is climate-, carbon offset- or CO_2-neutral, 7) labels that claim unaccounted CO_2 compensation measures, 8) general sustainability labels, 9) printed or online available sustainability reports and 10) a QR-code on the shelf or product leading to a source of further information.

Different studies have tried to find out what design criteria are preferred by consumers. In a study from Hartikainen et al. (2014) consumers preferred the label with a scale, the label showing that a product has low emissions in comparison with others in the same product category and the label giving an exact number of CO_2e emissions. Furthermore, participants in the study opted for labels that are clear and informative and enable a quick comparison (Hartikainen et al., 2014). Other studies found that consumers prefer scale labels which use a traffic light colour system (Emberger-Klein & Menrad, 2018; Upham et al., 2011). Labels that show exact numbers of CO_2e emissions have been critisised for different reasons. Schaefer & Blanke (2014) argue that it is difficult for the consumer to judge the values without any comparable CO_2e values at hand. Also, the calculation of exact numbers is complex if not impossible (Röös & Tjärnemo, 2011). Additionally, an exact number has difficulties in accounting for variations in the emissions of products. Horticultural products are just one example where data might substantially differ throughout the years, depending on uncontrollable natural factors or fluctuating harvests (Röös et al., 2010). Here, the goal of a labelling system becomes an important factor. If it is supposed to lead producers to a reduction of emissions in their production, data has to be collected for each producer and ideally for each year to generate the most accurate results. However, this procedure would punish producers for factors that they have no influence on, since a bad harvest results in higher CO_2e emissions per kg of produce (Röös et al., 2010). Schaefer & Blanke (2014) argue therefore, that the communication of a continual improvement process might fit the goal of informing about the reduction of emissions. Röös & Tjärnemo, 2011) discuss a number of different design criteria for a carbon label. A label indicating that a product has emitted less CO2e than the average product is even more complicated to calculate than the total number of CO_2e because a

baseline is also needed for the calculations. Total numbers of CO_2e are difficult to understand but could be normalised. In general, the goal of the label must be known in order to identify the optimal design. A combination of information and e.g. a traffic light scale would enable both educational purposes and making it easier for consumers to choose between different products (Röös & Tjärnemo, 2011). The problem with a label, that is given to products where efforts have been made to lower the emissions, is that more harmful products could still get the label and the important choice is not facilitated. The choice between labelled rice and unlabelled rice would be less substantial in terms of emissions saved than buying potatoes instead of rice (Röös & Tjärnemo, 2011). Also, according to (Röös & Tjärnemo, 2011) an efficient carbon labelling system must be designed to stimulate vegetarian or vegan diets.

Apart from the visual design criteria, there are additional factors that are considered to be important for a successful carbon footprint label. “The labeling should be salient, reduce information asymmetry between firms and their customers, and provide information clarity, payoff transparency, and credibility” (Groening et al., 2014). Schaefer & Blanke (2014) mention six criteria that a carbon label needs to fulfill: Completeness, meaning that the carbon management is integrated into the sustainability context; transparency in the carbon assessment methodology; reliability through the use of trustworthy emission data; clarity of the label to be easily understood by consumers; availability and accessibility, meaning that values are based on the same units; and an incentive for the producer for continuing to improve their processes to reduce emissions. Uniformity is not only important for the index used to display the magnitude of the carbon footprint (Cohen & Viscusi, 2012), but also for the appearance of a label on the market (Hartikainen et al., 2014).

(Röös et al., 2010) have carried out a study to examine the uncertainty of a carbon footprint and to provide implications for further design attempts. As mentioned previously, carbon footprints can change depending on natural events or the harvested amounts. Therefore, uncertainty assessments exist that refer to quality indicators that need to be fulfilled. The database ecoinvent uses seven different quality indicators to ensure the informative value of its entries (Röös et al., 2010). Carbon footprint labels need to be able to communicate the range of uncertainty with confidence, in order to ensure the possibility of a product comparison and to influence consumer behaviour (Röös et al., 2010). This needs to be regarded especially while educating consumers about what large amounts of CO_2e are and what low amounts are. Including ranges of emissions in a label might cause further confusion, but not communicating them at all would give them a sense of false accuracy (Röös et al., 2011).

According to Thøgersen & Nielsen (2016) a carbon footprint label should include a way of communicating the relative performance of a product in addition to the absolute numbers of its

carbon footprint to enable consumers to understand the label more intuitively. One way could be to compare the emissions caused by the product to the distance travelled by a car that causes the same amount of CO_2e be emitted or a comparison with the emissions associated with flying a certain distance that is familiar to the consumers (Upham et al., 2011). In general, the communication of LCA data needs to be normalised when presented to the consumers (Upham et al., 2011). Equally important in order to reduce the overall emissions from food consumption is a system that allows comparison between different types of products on a regional or even national level (Röös et al., 2010). Here, yet another difficulty lies in the ability of consumers to evaluate different values of CO_2e, especially when different units or package sizes are included (Schaefer & Blanke, 2014). Research still needs to find out, what products can be compared. A key criterion for a comparison between different product categories is interchangeability from a functional point of view, e.g. regarding the nutrient content, the energy or the protein content (Röös et al., 2010; Röös & Tjärnemo, 2011).

Not only do consumer preferences indicate that simpler labels are valued more than more complicated ones, but also from a psychological point of view it is reasonable to choose a simpler design over a label including too much information. More than four or five pieces of information lead to the consumer being overwhelmed and not processing the main message of a label. The result is that the label may not be payed attention to at all (Cohen & Viscusi, 2012). Hence, in regard to an activity of low involvement like grocery shopping, consumers might understand simpler labels better than complex ones (Thøgersen & Nielsen, 2016). Only (Röös & Tjärnemo, 2011) found that research is inconsistent and some consumers prefer a simple logo and some prefer a label with more information.

The effect of overwhelming consumers applies also to labelling too many products. Cohen & Viscusi (2012) claim that if every product category is labelled as potentially harmful for the environment, consumers will be confused about when to worry about the carbon footprint. As a solution Cohen & Viscusi (2012) suggest that labelling only product categories with significant carbon footprints and the potential to save a larger amount of emissions helps the consumer to make more meaningful choices (Cohen & Viscusi, 2012). Thøgersen & Nielsen (2016) go even further by saying that labelling “the least environmentally friendly alternatives is more effective in changing consumer behavior than positive labeling of environmental friendly products”.

Carbon labelling also struggles to evaluate the emissions of the product at the point of consumption. Products that are sold ready to consume might be emitting less CO_2 in their entire life cycle than product alternatives that need to be prepared by the consumers, e.g. by cooking. This can potentially be solved by including recommendations for the consumption on

a carbon label seperately on the product, like advising consumers to wash at a certain temperature, in order to facilitate a reduction of emission at the point of use (Klockenhoff, 2009).

No matter what information is optimally displayed on a carbon label, it has to compete with a rich environment of other types of information on a product. Thus, the size of the label needs to be carefully adjusted in order to be salient in itself (Beattie & McGuire, 2015). In an empirical study using eye-tracking to monitor the gaze of participants, the mean fixation level indicated that a carbon footprint label was as salient as other features displayed (Beattie & McGuire, 2015). Web instruments and the education of the costumer are another tool to facilitate the use of a label (Canavari & Coderoni, 2020). Therefore, additional climate-relevant information can be displayed in supermarkets in order to improve the performance of carbon labels (Emberger-Klein & Menrad, 2018).

4.4. Effects of a product carbon footprint label on consumer behaviour

While the previous part focussed on summarising literature about the different ways of designing a carbon label and important criteria that need to be considered, the following section aims to give an insight on the effects of a carbon footprint label on consumer behaviour. Therefore, empirical studies are used first and then more theoretical approaches to consumer behaviour are presented.

Although Hartikainen et al. (2014) discovered in their study, that consumers confronted with a carbon label state that it would have only a little to no impact on their buying behaviour, confirmed by Emberger-Klein & Menrad (2018), other studies have found out that consumers are willing to pay (WTP) extra for fair-trade labelled products. This extends to products with less carbon emissions, but the willingness to pay is significantly lower than for the fair-trade products (Akaichi et al., 2016). On special occasions both labels seem to compete, resulting in consumers buying the cheaper product out of both (Akaichi et al., 2016). Another study by Canavari & Coderoni (2020) has found that consumers respond more to products with a carbon footprint label in comparison to conventional ones. Also, they discovered that respondents who believe that the purchase of a product with a lower carbon footprint helps fighting climate change have a higher willingness to pay and that more price-sensitive people are less likely to pay more for a lower carbon product. The same study concluded from a literature review that Italian and German consumers have no higher WTP for lower carbon products and that young consumers and female consumers generally have a higher WTP for lower carbon labelled products (Canavari & Coderoni, 2020). Nonetheless, they found a positive WTP among 76% of the participants of their empirical study and that the animal origin of a product has a positive

influence on the WTP. A consumer study conducted by Vanclay et al. (2011) in an Australian supermarket, that used a colour scale on products to indicate their carbon footprint, was able to observe a small increase of green (lower carbon footprint) labelled products and a small decrease of black (higher carbon footprint) labelled products though the results were not statistically significant. However, they identified three different trends of responses. When the green labelled product was also the cheapest, they measured a strong response. When the green labelled product was not the cheapest, the response was weaker. In a third situation other factors dominated over the carbon footprint and the price, e.g. the functional use of a certain container size. From these findings was concluded that a combination of a carbon footprint label and a price incentive might be effective (Vanclay et al., 2011). Camilleri et al. (2019) found that a when information of the emissions of CO_2e was presented in a relatable format, consumers bought products with lower carbon footprints more frequently. It was noticed that a carbon label may function as a signpost reminding consumers of their values. Moreover, it was acknowledged that knowledge alone does not change behaviour. Perceived behavioural costs, norms and identity are also influencing it (Camilleri et al., 2019). As reported by Thøgersen & Nielsen (2016) “a carbon footprint label significantly influences consumers' choices of a fast-moving consumer good”. The use of colours to indicate the carbon footprint significantly increases the effectiveness of a product carbon footprint label (Thøgersen & Nielsen, 2016).

Groening et al. (2014) claim, that females will utilise carbon footprint labels for their decisions more often than males, that more educated consumers will make use of a carbon label more than less educated consumers and that younger consumers will use a label more than older consumers. This claim is extended by Steiner et al. who say that “consumers in the ecologically-oriented class are more likely to be characterized by female consumers”. Overall, carbon footprint labelling can help to improve the effectiveness of measures to facilitate pro-environmental behaviour, even more so for highly ecologically oriented consumers (Steiner et al.). This means that carbon labelling can have an effect on consumers with the matching implicit attitude (Beattie & McGuire, 2015) and that this effect is stronger the more environmentally concerned consumers are (Thøgersen & Nielsen, 2016). This implies, that more environmentally concerned consumers are able to receive, process and believe the information provided by a carbon label better in order to refresh their beliefs, which is crucial for a label to be effective (Cohen & Viscusi, 2012; Steiner et al.). Steiner et al. differentiate between the segment of ecologically oriented consumers and price-sensitive consumers, whereas the ecologically oriented consumers are less likely to some psychological biases. The factors that contributed to the identification of those segments “were found to be motivation in terms of reported attention to product label information, several lifestyle attributes, ecological

attitude, involvement with the product, as well as personal values" (Steiner et al.). Furthermore, the ecological consciousness is influenced by altruism and the perceived effect of the individuals' behaviour (Steiner et al.).

The effectiveness of a carbon label is important in order to justify the use of time and resources for developing a functional system. What speaks against the success of carbon labelling initiatives is, that at this point in time there is reason to believe that many consumers do not think of the carbon footprint of a product when purchasing them. Other factors such as health, security and social issues rank higher than environmental concerns among the UK public (Upham et al., 2011). Accordingly, only a low percentage of the population is expected to make use of a carbon label for their purchases without any other incentive (Upham et al., 2011). This is critical since in order to reduce emissions notably, consumers would need to buy about 40 items per week with a significantly lower carbon footprint (Upham).

Röös & Tjärnemo (2011) conducted a detailed literature review in order to help understanding consumer behaviour related to product carbon footprint labelling. They draw from the results of studies on organic food and apply those to the field of carbon labelling. Therefore, several assumptions are made. The main motivators for buying organic foods are altruism, ecological reasons and universalism, as well as personal health reasons (Röös & Tjärnemo, 2011). If the latter dominate over the others, results drawn for predicting the buying behaviour of carbon labelled products are less applicable, since these do not provide any personal health benefits (Röös & Tjärnemo, 2011). Moreover, Röös & Tjärnemo (2011) identify several reasons for the attitude-behaviour gap that is observable for environmental issues. First, a high perceived price prevents the purchase of lower carbon products, especially because the personal benefits are nonexistent in contrast to organic products which reduces the WTP. Second, habits and previous experience often determine the behaviour during buying decisions because shopping for food usually requires low involvement and limited problem solving. Particularly if the habit is strong it predicts behaviour better than attitudes. Moreover, habits prevent reflection over a specific behaviour. In the event of a crisis however, a window of opportunity for breaking habits opens up. Third, the availability of special products like organic food or carbon labelled products is perceived to be low. Fourth, the marketing and information need to be considered. As mentioned in other studies, as well, Röös & Tjärnemo (2011) point out that consumers have limited knowledge of food consumption and its complex environmental impacts. Therefore, the design of the label must be chosen with care. Fifth, a great number of labels confuse the consumer and damage the amount of trust that they have in the label. Thus, it is important to have a transparent labelling system with additional background information available to the consumer. Sixth, consumers need to believe that their actions will have an actual effect (Röös & Tjärnemo, 2011).

As reported by Cohen & Viscusi (2012), there are three mechanisms to induce a desired effect. First, a behaviour may be desirable by the person itself, e.g. due to financial benefits or the personal environmental attitude. Second, a behaviour may result from the development of personal norms that are regarded as attractive by the person itself. Third, external norms established by others pressure the individual to adopt a certain behaviour (Cohen & Viscusi, 2012). If the peer group of an individual pays great attention to carbon emissions, the affected person will adapt their behaviour likewise (Groening et al., 2014). In addition to that, there are other mechanisms that influence behaviour in regard to purchasing situations.

Steiner et al. differenciate between proximate behavioural causes and ultimate behavioural causes. Proximate behavioural causes are put forward by the theory of planned behaviour, which states that subjective norms, perceived behavioural control and the evaluation of a behaviour by an individual are responsible for its intended behaviour and ultimately for their actual behaviour (Ajzen, 1991). Ultimate behavioural causes refer to more or less instantaneous psychological triggers for the behaviour (Steiner et al.). This relates to the way the human brain was used in the early stages of the human development, when there was a physical and instinctual link between behaviour and the environment (Steiner et al.). Nowadays, consumption patterns are characterised by a detached behaviour from its environmental consequences and knowledge about this phenomenon allows to adapt strategies to change consumption behaviour accordingly (Steiner et al.). Often, consumers are unaware of their habitual behaviour because the driving processes behind it are not open to introspection (Beattie & McGuire, 2015). These are guided by implicit attitudes which are distinguished from explicit conscious attitudes. The latter are happening consciously, controlled, reflectively, and slowly whereby implicit attitudes are “considered to be unconscious, automatic, impulsive, and fast“ (Beattie & McGuire, 2015).

This often applies to purchases that happen frequently like buying grocery products. The decision is generally the outcome of simple choice heuristics and happens quickly (Groening et al., 2014). Therefore, carbon footprint labels are unlikely to change consumption habits of commonly purchased products (Groening et al., 2014). According to Röös & Tjärnemo (2011), food purchasing will always be subject to habits and quick decisions of low involvement.

Gadema & Oglethorpe (2011) predict a grim future for the effects of a carbon labelling system. Although most consumers are expected to have a positive attitude towards carbon labelling of food products, it alone will not result in a substantial change in food systems (Gadema & Oglethorpe, 2011).

5. Results of the survey

In this section, the results from the survey are presented. The complete set of answers can be viewed in Appendix 3. For a general overview and in order to contextualise the findings, descriptive statistics are provided, before the hypotheses are presented and tested with the corresponding statistical tests.

5.1. Descriptive statistics

The survey was undertaken in August 2020 and lasted for six days, before it was manually stopped. It was started by 209 participants, but only n=158 complete set of answers were submitted. Therefore, the completion rate was 75.6%. Most participants were female (75% of the participants) and between the ages of 18 and 29 (73%). Moreover, most of the participants were living in Germany (96%) and currently studying (66%). The total demographic results are presented in Table 1 and Table 2.

Table 1: Demographics part I

	Age range		Gender
Under 18	1	Female	119
18-29	115	Male	37
30-44	15	Diverse	1
45-59	15	NA	1
60-74	9		
75 or over	3		
Total	**158**		**158**

Table 2: Demographics part II

	Occupation		Country of residence
Student	104	Germany	151
In apprenticeship	3	United Kingdom	5
Looking after home or family	1	Denmark	1
Employed	36	Scotland	1
Self-Employed	7		
Unemployed/Looking for work	1		
Retired	6		
Total	**158**		**158**

On average, the participants gave high ratings for the statements describing their environmental attitude and behaviour. For instance, the statement “The environmental performance of a product is an important criterion for me when shopping for groceries.” received an average rating of 3.9 out of 5. P2Q5, “I think of myself as someone who is very concerned with environmental issues.”, had a mean rating of 3.8 out of 5. The mean ratings for each question to be evaluated on a Likert scale from 1-5 and their median can be viewed in Appendix 1, Table 3.

The participants' previous knowledge about product carbon footprints and life cycle assessments seemed to be rather high. Almost all stated, that they know what an ecological footprint is (yes: 153 votes, no: 5 votes) and two thirds have calculated their ecological footprint before (yes: 104 votes, no: 53 votes, NA: 1 vote). Also, a majority of participants has already heard of product carbon footprints (yes: 138 votes, no: 19 votes, NA: 1 vote) and many have heard of life cycle assessments before (yes: 70 votes, no: 87 votes, NA: 1 vote). However, when they were asked to evaluate their ability to perfectly describe both terms the mean score was 3.6 for product carbon footprints and 2.2 for life cycle assessments. In addition, the participants were asked to list three factors that they think contribute the most to the emissions caused by grocery products, allowing for 474 answers in total. The results are presented in Figure 1. Answers were only included when they occurred at least 10 times. The most frequently mentioned factors were transport (n=102), production related factors (n=45), meat and beef production and consumption (n=32) and the packaging of the products (n=29). 59 times no answer was given.

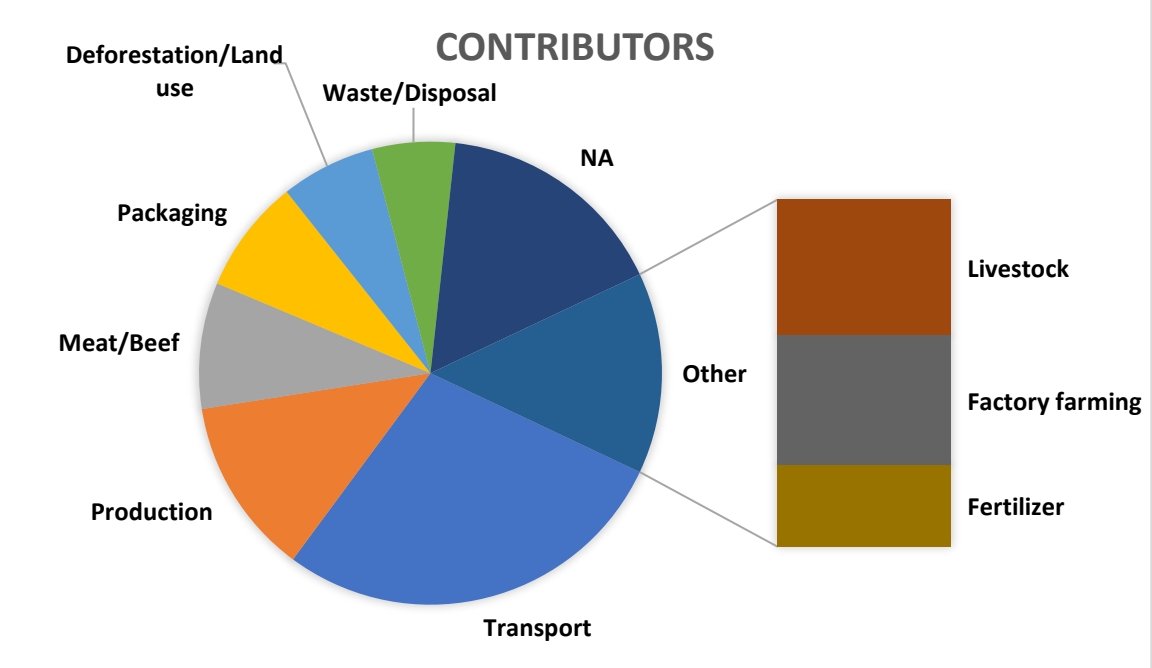

Figure 1: Stated contributors to emissions caused by grocery products

Most participants thought communication of the information about product carbon footprints and life cycle assessments provided to them before this question is important for a product carbon footprint label to be useful (mean score of 4.3). When they were asked to rate statements about how this kind of information should be supplied, the mean score for communication directly through the label was 3.9 and for a separate provision e.g. via a website the mean was 2.9. With the mean score of 2.7 only slightly directed towards this kind of information being explained as detailed as possible, the participants preferred an average complexity of the information.

Concerning the design criteria of a product carbon footprint label, a design with a visual guidance tool comparable with a traffic light (mean rating 4.4), a design allowing for comparison within a product category (mean rating 4.2) and a simple design including a QR-code that leads to a website with more detailed information (mean rating 4.1) were considered to be very valuable.

With a mean rating of 4.2, most participants agreed, that a product carbon footprint label would influence their buying decisions and that they were willing to pay more money for product alternatives with a lower carbon footprint (mean rating 4.0). Lastly, the participants were asked to list three factors that would make them choose a low carbon product when they have several to choose from. The results are presented in Figure 2. Answers were only included when they occurred at least 10 times. The most frequently mentioned factors were price (n=72), the quality of the product (n=36), regionality of the product (n=22) and the comprehensibility and transparency of the information on a label (n=22). 151 times no answer was given.

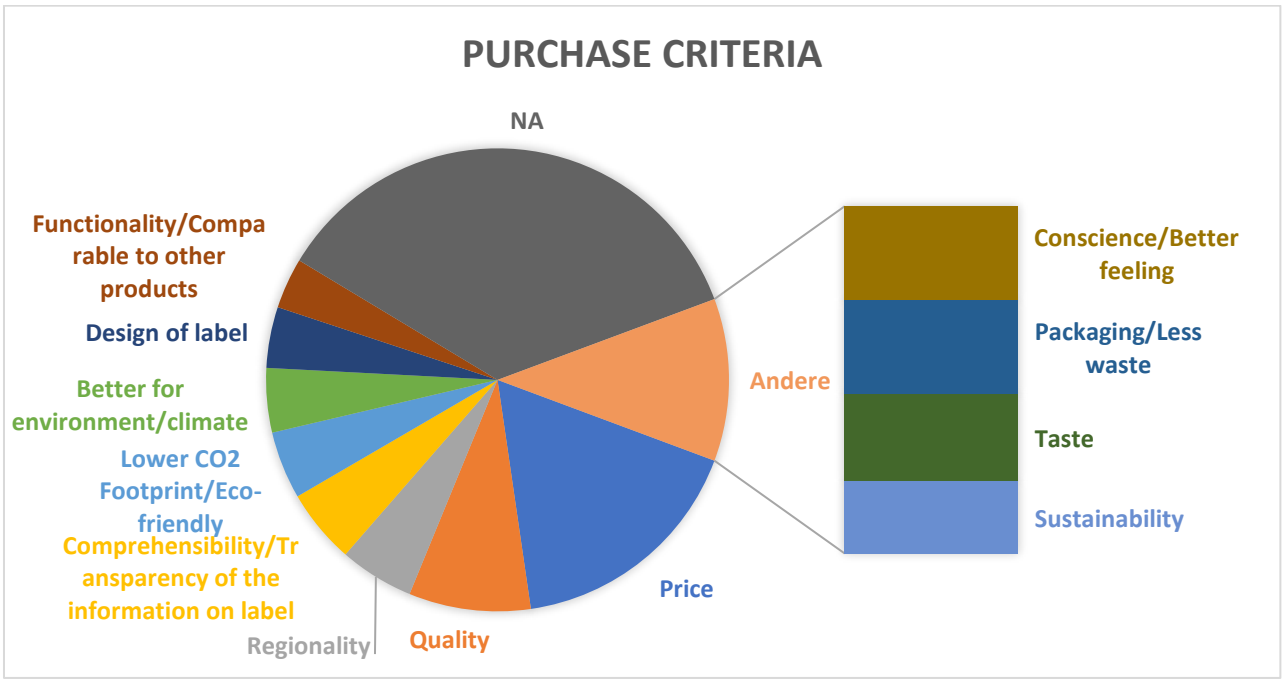

Figure 2: Stated purchase criteria of participants

5.2. Statistical tests for hypotheses

The hypotheses were chosen from a set of 15 individual ones. The hypotheses were excluded if the response format of the questions from the survey didn't allow for appropriate testing or if they were less relevant to gather information in regard to the research questions. Nonetheless, they were included in the discussion since they contribute to the topic of product carbon footprint labelling and consumer behaviour. Subsequently, the remaining six hypotheses are

presented and statistically tested according to the data format of the responses involved. The complete results of all statistical tests can be viewed in Appendix 1.

Hypothesis 1: There is a significant difference between age groups and their environmental attitude and behaviour.

This hypothesis involves P1Q1 (ordinal response format) and P2Q1-6 (ordinal response format). The data is non-normally distributed and has more than two unpaired datasets. Therefore, a Kruskal-Wallis test was used. H_0, no difference of the variables, was rejected when the p-value was within the significance interval of $p > 0.05$. The test was conducted for each combination of P1Q1 with the other questions mentioned above. The difference between P1Q1 and P2Q1+2, as well as P1Q1 and P2Q5+6 is not significant with a p-values above $p = 0.05$. The difference between P1Q1 and P2Q3+4 is significant with p-values below $p = 0.05$.

Hypothesis 2: There is a significant difference between age groups and prior knowledge about PCF and LCA.

This hypothesis involves P1Q1 (ordinal response format), P3Q1-4 (dichotomous response format) and P3Q5-7 (ordinal response format). The data is non-normally distributed and has more than two unpaired datasets. For the combinations of P1Q1 and P3Q1-4, a Chi-squared test was used and additionally a Fisher's exact test, because some of the combined observations occurred less than five times. H_0, an independence of the variables, was rejected when the p-value was within the significance interval of $p < 0.05$. P1Q1 and P3Q1+4 show a dependency with p-values above $p = 0.05$. P1Q1 and P3Q2+3 are independent with p-values below $p = 0.05$. For the combinations of P1Q1 and P3Q5-7 a Kruskal-Wallis test was used. The difference between P1Q1 and P3Q7 is not significant with p-values above $p = 0.05$. The difference between P1Q1 and P3Q5+6 is significant with p-values below $p = 0.05$.

Hypothesis 3: The concern about environmental issues and stated importance of climate change have a significant influence on prior knowledge about PCF and LCA.

This hypothesis involves P2Q5+6 (ordinal response format), P3Q5-7 (ordinal response format). The data is non-normally distributed and it is tested for the linear relation of two variables. Therefore, Spearman's rank correlation was tested. All results are statistically significant (p-value < 0.05), except for the combination of P1Q1 and P3Q6. No strong correlation could be identified, since all correlation values are below 0.36.

Hypothesis 4: The concern about environmental issues and stated importance of climate change have a significant influence on stated influence of a label and willingness to pay (WTP).

This hypothesis involves P2Q5+6 (ordinal response format), P6Q1+2 (ordinal response format). The data is non-normally distributed and it is tested for the linear relation of two

variables. Therefore, Spearman's rank correlation was tested. All results are statistically significant (p-value < 0.05). No correlation could be identified, since all correlation values are below 0.28.

Hypothesis 5: People who state they have better knowledge about PCF and LCA prefer more detailed labels/People who state they know less prefer simpler labels.

This hypothesis involves P3Q1-4 (dichotomous response format) and P3Q5+6 (ordinal response format), P4Q5 (ordinal response format) and P5Q2 (ordinal response format). For the combinations of P3Q1-4 and P4Q5 and P5Q2, the data is non-normally distributed and two unpaired datasets are compared. Therefore, a Mann-Whitney U test was used. H_0, an identical mean, was rejected when the p-value was within the significance interval of $p < 0.05$. This is only the case for the combination of P3Q3 and P5Q2. For the combinations of P3Q5+6 and P4Q5 and P5Q2 Spearman's rank correlation was tested. Only the values for the combinations P3Q6 and P5Q2, as well as P3Q5 and P5Q2 are statistically significant (p-value < 0.05). No correlation could be identified, since all correlation values are below 0.26.

Hypothesis 6: People who state they have better knowledge about PCF and LCA give higher score on label that shows total amount of CO_2e.

This hypothesis involves P3Q1-4 (dichotomous response format) and P3Q5+6 (ordinal response format), as well as P5Q3 (ordinal response format). For the combinations of P3Q1-4 and P5Q3, the data is non-normally distributed and two unpaired datasets are compared. Therefore, a Mann-Whitney U test was used. H_0, an identical mean, was rejected when the p-value was within the significance interval of $p < 0.05$. This is only the case for the combination of P3Q2 and P5Q3. For the combination of P3Q5+6 and P5Q3 Spearman's rank correlation was tested. Only the value for the combination P3Q5 and P5Q3 is statistically significant (p-value < 0.05). No correlation could be identified, since all correlation values are below 0.21.

6. Discussion

This paper aims to find out how a product carbon footprint label can be designed to facilitate consumer behaviour towards more sustainable buying decisions. More specificly, it investigates a) what elements can help to make complex knowledge about product carbon footprints and life cycle assessments comprehensible for non-academic target groups and other target groups being unfamiliar with the terminology on the example of a product carbon footprint label, b) what knowledge gaps consumers have regarding product carbon footprints and life cycle assessments that need to be addressed by a product carbon footprint label and c) what criteria must be met by a product carbon footprint label in order to be accepted by

consumers in a way that it positively influences their buying behaviour. This is done by reviewing relevant literature and an accompanying consumer survey. The results are discussed and additionally a concept proposal summarises the implications for the implementation of a carbon footprint labelling system for food products.

The survey results are likely to be biased. A recruiting bias was caused by the distribution of the survey via different networks of the Leuphana University of Lueneburg, resulting in a significant over-representation of participants being female, between the ages of 18 and 29 and students (Donner-Banzhoff & Bösner, 2013, p. 100). Since the university represents a sustainable philosophy and many students are educated about environmental sciences, it can be assumed that the participants are more environmentally concerned than the average person. The high average ratings for participants concerning their environmental attitude confirm this suspected bias. In order to minimise that bias the participants were not previously informed about the concrete subject of the survey and the survey was answered anonymously (view Appendix 2). Furthermore, the wish for social acceptance may have caused the participants of the survey to rank their environmental attitude and behaviour higher than it is in reality (Donner-Banzhoff & Bösner, 2013, p. 100). The over-representation of students of environmental science may have led to a more informed contribution of design criteria concerning a carbon footprint label. Nonetheless, the results of the study are still valuable as long as they are regarded as an explorative addition to the literature review.

The literature review shows, that consumers have substantial knowledge gaps concerning carbon footprints of food products and life cycle assessments (Camilleri et al., 2019; Canavari & Coderoni, 2020; Gadema & Oglethorpe, 2011; Gössling & Buckley, 2016; Hartikainen et al., 2014; Thøgersen & Nielsen, 2016; Upham et al., 2011). Although many are familiar with the terminology, they lack a deeper understanding of the concepts and the underlying mechanisms. Moreover, the emissions of the food sector are largely underestimated by many and consumers are unaware of the large contributing factors in regard to the emissions of different product life cycle stages. Because grocery shopping is a regularly practised activity with low involvement, consumers are usually not conscious of their knowledge gaps. This results in the difficulty for consumers to evaluate the information of carbon labels, especially when total numbers of CO_2e are included. These findings are partly supported by the results from the survey which show that although a majority is familiar with carbon footprints and life cycle assessments, the perceived ability to describe the terms has average ratings. Also, when the participants were asked to list the factors that they think contribute the most to the emissions caused by grocery products, the most mentioned factors were transport, production related factors, meat and beef production and packaging. This leaves out other important factors like emissions during the material extraction or the primary production, e.g. while raising

cattle for beef. In order for a carbon footprint label to be effective, consumers need to be able to process the information of it. The results from the survey of this study suggest, that age has a significant influence on the previous knowledge about carbon footprints and life cycle assessments, but this may be due to an assumed high number of younger participants to be students of environmental science at the Leuphana University of Lueneburg. However, there was no statistically significant correlation between the environmental concern and the stated importance of climate and the prior knowledge, which contradicts the findings from the literature review. This may be caused by the biased sample or the Spearman's rank correlation being not the ideal fit for data collected from the responses to a Likert scale. According to Lampert et al. (2017), “positive attitudes towards sustainability issues does not predict a more intensified search process for information.”

Therefore, ways to communicate this type of information need to be found. Not only is it important that consumers understand the underlying concepts, but they also need to be able to make quick use of it during purchasing situations. Thus, a carbon footprint label for food products faces the challenge of educating the consumers and providing relevant and accessible information to facilitate sustainable consumer behaviour. The question is if a carbon label can provide all that by itself or if other sources of information are needed in order to fulfill these requirements. Participants from the survey preferred the information about carbon footprints and life cycle assessments to be communicated directly by a carbon label. Nevertheless, there is reason to believe that this would diminish the overall functionality of it because the label would be overloaded with information since consumers are only able to process a limited amount of information at a time. The additional information could be communicated through other means, e.g. on a website or by the supermarkets. The results from the literature review show that consumers prefer labels using a scale and a colour code similar to traffic lights (Emberger-Klein & Menrad, 2018; Hartikainen et al., 2014; Upham et al., 2011). This is consistent with the results from the survey conducted for this paper. In general, it is advisable that a carbon footprint label uses transparent methods, trustworthy sources of data and clarity of the information displayed to enable all consumers to use it (Schaefer & Blanke, 2014). This includes the communication of uncertainties of the carbon footprint calculations (Röös et al., 2010). The challenge is not to confuse the consumers. For that reason, a multitude of different carbon labels should be avoided, as well. The visual appearance of a label is important in order to be able to compete with all sorts of influential sources that aim to influence consumer behaviour. Therefore, simpler labels are likely to be more effective since they allow easy access to the information and they are also preferred by consumers. However, participants of this survey chose a neutral rating on the complexity of information displayed indicating that they prefer labels that are not too complex but also not

too simple, as illustrated by some listed design criteria such as “simple design (I don't want to search for numbers)”, “redirecting to more information (e.g. QR-code)” or “contextualisation of CO_2 in numbers of °C, nobody can understand absolute numbers.” Thus, providing consumers with a reference tool can be helpful in order the facilitate the comparison of different products.

In order to determine the criteria that need to be met by a carbon label for consumers to accept it as a tool facilitating sustainable consumption behaviour, the consumer perception of carbon labels plays an essential role. Many European consumers advocate an implementation of carbon labels (European Comission, 2009). Still, in comparison with other labels they are among the least preferred. Additionally, other factors such as price, quality, taste and the origin of a product are considered to be more important than the environmental performance (Hartikainen et al., 2014; Lampert et al., 2017; Steiner et al.; Thøgersen & Nielsen, 2016; Upham et al., 2011). Similar results were found among the participants of this survey. De-Magistris et al. (2017) claim that consumers of a higher age concentrate on a healthier lifestyle, while younger people have stronger environmental concerns. In this study a significant difference could be identified between the age and the stated efforts to minimise the energy use for electricity and heating, as well as the adaption of the diet for environmental reasons. The environmental concern itself can be a predictor of the attitude towards carbon labelling (de-Magistris et al., 2017). Further research might help to identify, if a previous sign of environmental behaviour like a diet change has a significant influence on the knowledge about carbon footprints and life cycle assessments, as well as the stated influence of a carbon label. It could also be assumed that people that have better knowledge about those topics evaluate this kind of information to be more valuable than people with larger knowledge gaps. Mistrust of the effectiveness and in the motives of companies negatively influences consumer perception (Upham et al., 2011). Therefore, publically enforced labels are regarded as more trustworthy by consumers (de-Magistris et al., 2017).

The mechanisms of behaviour itself, especially sustainable behaviour, are crucial to understand in order to be able to influence it in a controlled manner. Insufficient measures might foster endorsed compensatory green beliefs that serve the purpose to either reduce feelings of guilt of actions with a negative environmental impact or to defend their image in social situations (Hope et al., 2018). In fact, many participants of this study referred to their feelings or conscience in regard to factors that influence their buying decisions. Furthermore, “a consumer could potentially offset environmentally protective actions by being more lax in other ways. This danger is particularly great if consumers overestimate the impact of their protective behaviors” (Cohen & Viscusi, 2012).

For a long time, consumer decisions were mainly viewed from a marketing perspective that relates to product characteristics like price and economic factors regarding the consumer (Maison, 2019, p. 23). The theory of planned behaviour (Ajzen, 1991) was used to assume that consumer decisions are directly and logically connected to the five phases that they go through while purchasing food products: “problem recognition, searching for information, alternative evaluation, final product choice (purchase), and post-decision evaluation” (Maison, 2019, p. 23). Yet, this theory has not proven to be of a good fit in this context. Marketing and consumer research suggests that mathematically calculating the highest utility of a product does not allow for a reliable prediction of the consumers use of the same (Maison, 2019, p. 24). A new approach emphasises on the fact that consumers are relatively unaware of the needs and motives that are responsible for their attitudes and choices. Also, consumer decisions are rarely caused by an in-depth analysis of the product information they are presented with (Maison, 2019, p. 26). More often automatic behaviour is triggered by stimuli that are not consciously perceived without the individual noticing it (Maison, 2019, p. 27). An experiment in which participants were shown a series of images of which some were presented repeatedly and in which they were asked to make a choice showed that participants preferred items simply because they seemed more familiar to them (Maison, 2019, p. 28). This so-called mere exposure effect needs to be considered carefully when strategies for marketing and qualitative research are developed (Maison, 2019, p. 28). Attention needs to be paid to the content that a stimulus communicates and for the associations it produces (Maison, 2019, p. 28). In psychology, the view of a person shifted from a rational being that is aware and in control of their ongoing psychological processes (homo oeconomicus) to a more unconscious human being that is not in control of all areas (homo automaticus) (Maison, 2019, p. 31).

With all that in mind it seems quite impossible to develop the perfect carbon footprint labelling system for food products and predict the effects that it may have on consumers. Nevertheless, perfection is highly subjective and a carbon labelling system can be designed to serve a goal to the best of its capabilities, as long as it does not backfire due to unnoticed factors. In the following an attempt is made to include as many of the factors developed throughout this paper important for a carbon label in a concept proposal to serve as an inspiration for further research and carbon labelling initiatives.

7. Concept proposal: A combining design

The goal of a carbon label, the knowledge gaps of consumers, consumer perception of carbon labelling, psychological mechanisms of behaviour, the visual design of a label, the

infrastructure of the system in which a carbon label is planned to be deployed and many more factors need to be considered in order to develop a functional and effective label.

The overall goal of a carbon label for grocery products should be to reduce the emissions caused by food consumption. However, this goal can be approached from different directions. Designing it in a way that it enables consumers to make the more environmentally friendly choice is a direct way to reduce emission and has the potential to have a quick impact. Here, the knowledge gaps, consumer perception, psychological aspects and the visual design are important. A simple design that is quick to understand can help to overcome these knowledge gaps. To focus on total numbers of CO_2e does not seem advisable at this point in time, since many consumers struggle to evaluate this kind of information. Once the general public is more used to the concept, this might change. Instead, the communication of key factors of CO_2e emissions for larger product groups may be more effective (Kranke, 2009). This also has the benefit of saving time and resources, which is generally important in the fight against climate change. To improve the consumer perception of carbon labelling, several factors are important. Design criteria preferred by consumers should be included. Thus, a label with a colour code like a traffic light needs to be chosen. Also, the label should be publicly enforced by an institution like the European Union to improve consumer faith and avoid the establishment of too many labels. As of now, the EU has already set different legislative standarts in place that secure access to complete information for consumers (de-Magistris et al., 2017). An initiative by Oatly, a Swedish company, has gathered the support of many Germans to force the German parliament to discuss making carbon labelling mandatory (Oatly, 2020a). It is often observable that governments are very careful to establish innovative or controversial policies due to the fear of not being re-elected. Carbon labelling is usually not desired by many large companies. In 2009, 10 German companies calculated the carbon footprint of their production and came to the conclusion, that a communication of this information to the consumer via a carbon footprint labels is not advisable (Kranke, 2009). From the perspective of retailers, a carbon label could significantly influence the market mechanics by promoting labelled products in comparison to not yet labelled product categories. This is problematic because retailers would be required to voluntarily switch from high carbon to low carbon products. Although this seems desirable from an environmental perspective, it is utopian as there would need to be a way to make all competitors switch to carbon labelled products at once to flatten the playing field and enable healthy competition (Gadema & Oglethorpe, 2011). However, a strict mandatory policy would enable a widespread and simultaneous implementation (Gadema & Oglethorpe, 2011). The support of the national governments from a larger institution like the EU can help to take pressure away and facilitate the introduction of stricter policies. The exceptional situation of the 2020 corona pandemic serves as an extreme example as mandatory regulations were

applied on a multinational scale. Of course, the situation was more immediate and chaotic than a carbon labelling system should be and the measures taken into action were often far from carefully worked out. But in the long term, climate change is as life threatening and dangerous as the virus outbreak and justifies the need of consequent and strict policies. In fact, the EU has brought a research program to life that aims to develop ways for the implementation of an environmental footprint scheme for products (European Comission, 2019). According to Upham et al. (2011), a carbon reduction label needs to be widely applied in order to play a significant role in the shift to a low carbon economy.

To guarantee the long-term change towards a low carbon industry, consumers need to overcome the knowledge gaps concerning the carbon footprints of a product and its underlying concept, as well as the emission factors of food products. Not all of the information can or should be provided by a carbon label alone. It is therefore necessary to provide consumers with an easy way to access further information. In the age of digitalisation, different options are imaginable. A QR-code on the carbon label can lead to a website containing information on the methods of carbon labelling, magnitudes of CO_2e values, the large emission contributors of food products and other educational aspects that help to integrate the whole idea of a low carbon economy into the minds of the consumers. The information can be prepared in different formats like short informational texts, graphics and pictures or videos like the one that Upham et al. (2011) produced for their study in order to address a large spectrum of consumer types. Mobile apps can be of special interest, as they are easy to access directly in the shopping situation via mobile phones. There are already some examples of mobile apps that try to educate consumers about the emissions of consumption goods and services and to facilitate a more sustainable behaviour (imovesmart, 2020; JouleBug Enterprise, 2020; Oroeco, 2020). However, as already mentioned, it has to be taken into account that too many different sources of information can lead to the confusion of consumers.

8. Conclusions

There is no such thing as the perfect carbon label. Research shows that there are many important factors to be considered that influence the success of it. Most importantly, the goal of a carbon label needs to be defined before thinking about the content of information and the design criteria. Therefore, the concept proposal should not be used as a guideline, but more as a means of inspiration for further research. Nevertheless, with the combined goal of educating consumers and facilitating sustainable consumption behaviour, a carbon label is likely to perform better if it is a) simply designed and easy to remember, b) not containing too many pieces of information, c) allowing for a comparison within and among product categories,

d) using a functional unit, e.g. nutrition content, to enable a comparison, e) including a colour scale, f) providing a link to further information, e.g. using a QR-code leading to a website, g) publically enforced and mandatory, h) universal on a large scale like the EU or at least based on a meta-label to make it similar across different countries. Total numbers of CO_2e should be included with care and not as the main transmitted message as it may not be available for all products and subject to variance and a reference unit should be used, e.g. the emissions converted to a car drive or flight. Still, the information displayed should be based on the most accurate calculation possible or if no data is available on the large emission contributors of the product category. Further research should also aim at finding out how to develop a system for the uniform use of system boundaries for life cycle assessments in order to create more transparency and how the uncertainty limits of these boundaries can be communicated to consumers.

Despite all difficulties, a properly designed carbon label has the potential to save a substantial amount of emissions if it leads to a large number of lower carbon choices (Upham et al., 2011).

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Appendix

1 List of tables and figures

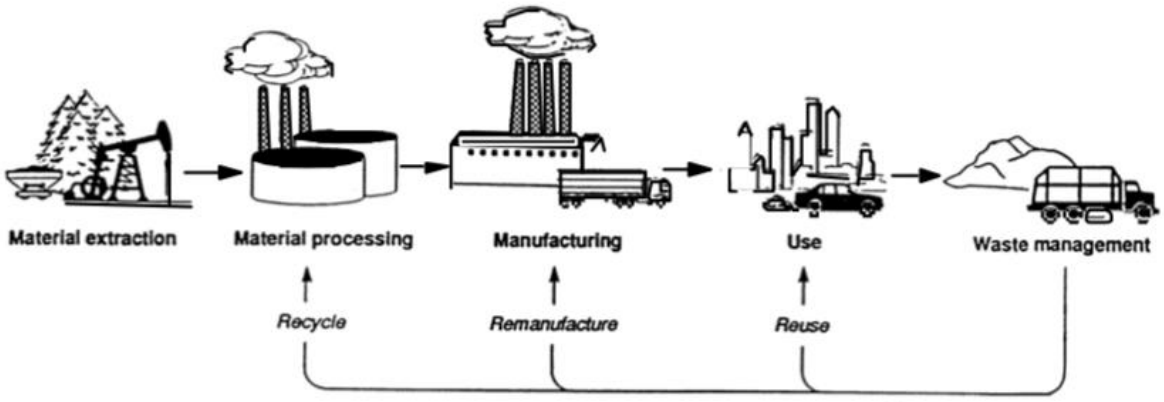


Figure 3: The phases of a product life cycle (Matthews et al., 2014)

Table 3: Mean answers of the questions of the survey and their median

Question	Mean	Median
P2Q1	3.689873	4
P2Q2	3.43038	4
P2Q3	3.624204	4
P2Q4	3.607595	4
P2Q5	3.765823	4
P2Q6	4.398734	5
P3Q5	3.620253	4
P3Q6	2.178344	1
P3Q7	4.178344	4
P4Q1	4.288462	5
P4Q2	4.165605	4
P4Q3	3.902597	4
P4Q4	2.948387	3
P4Q5	2.698718	2.5
P5Q1	4.443038	5
P5Q2	2.608974	2
P5Q3	3.235669	3
P5Q4	4.184713	4
P5Q5	3.246835	3
P5Q6	4.120253	4
P6Q1	4.235669	4
P6Q2	4.056962	4

Table 4: Results Kruskal-Wallis test for hypothesis 1

Questions	Kruskal-Wallis chi-squared	p-value
P1Q1 x P2Q1	4.91	0.2967
P1Q1 x P2Q2	7.9478	0.09351
P1Q1 x P2Q3	12.902	0.01177
P1Q1 x P2Q4	18.891	0.0008256
P1Q1 x P2Q5	5.7997	0.2146
P1Q1 x P2Q6	2.5627	0.6334

Table 5: Results Chi-squared test and Fisher's exact test for hypothesis 2

Questions	Chi-squared test		Fisher's test
	X-squared	p-value	p-value
P1Q1 x P3Q1	18.326	0.002565	0.01057
P1Q1 x P3Q2	56.142	7.597e-11	2.367e-12
P1Q1 x P3Q3	1.5123	0.9116	0.6939
P1Q1 x P3Q4	15.526	0.008336	0.002532

Table 6: Results Kruskal-Wallis test for hypothesis 2

Questions	Kruskal-Wallis chi-squared	p-value
P1Q1 x P3Q5	23.211	0.0001149
P1Q1 x P3Q6	17.785	0.001359
P1Q1 x P3Q7	2.5304	0.6392

Table 7: Spearman's rank correlation for hypothesis 3

Questions	Cor	p-value
P2Q5 x P3Q5	0.2442277	0.001985
P2Q5 x P3Q6	0.2101736	0.008242
P2Q5 x P3Q7	0.3367517	1.615e-05
P2Q6 x P3Q5	0.2781296	0.0004026
P2Q6 x P3Q6	0.1524198	0.05669
P2Q6 x P3Q7	0.3545309	5.223e-06

Table 8: Spearman's rank correlation for hypothesis 4

Questions	Cor	p-value
P2Q5 x P6Q1	0.1919838	0.01601
P2Q5 x P6Q2	0.2763992	0.000439
P2Q6 x P6Q1	0.1871963	0.01889
P2Q6 x P6Q2	0.1761725	0.02681

Table 9: Results Mann-Whitney U test for hypothesis 5

Questions	p-value
P3Q1 x P4Q5	0.6271
P3Q1 x P5Q2	0.3911
P3Q2 x P4Q5	0.09867
P3Q2 x P5Q2	0.1273
P3Q3 x P4Q5	0.1252
P3Q3 x P5Q2	0.02886
P3Q4 x P4Q5	0.8299
P3Q4 x P5Q2	0.2626

Table 10: Spearman's rank correlation for hypothesis 5

Questions	Cor	p-value
P3Q5 x P4Q5	0.1531416	0.05631
P3Q5 x P5Q2	0.2632614	0.0008987
P3Q6 x P4Q5	0.08869957	0.2724
P3Q6 x P5Q2	0.1695689	0.03492

Table 11: Results Mann-Whitney U test for hypothesis 6

Questions	p-value
P3Q1 x P5Q3	0.03092
P3Q2 x P5Q3	0.01166
P3Q3 x P5Q3	0.1075
P3Q4 x P5Q3	0.09883

Table 12: Spearman's rank correlation for hypothesis 6

Questions	Cor	p-value
P3Q5 x P5Q3	0.2141739	0.007071
P3Q6 x P5Q3	0.1109491	0.1679

2 Questions of the survey

Part and Topic	Question Code	Item	Phrasing	Data Type Response
Part I: Demographics	P1Q1	Age	Age Range	Ordinal
	P1Q2	Gender	Gender	Nominal
	P1Q3	Occupation	Occupation	Nominal
	P1Q4	Country of Residence	Country of Residence	Nominal
Part II: Participants' environmental attitude and behaviour	P2Q1	Importance of product environmental performance	The environmental performance of a product is an important criterion for me when shopping for groceries.	Ordinal
	P2Q2	Usage of green alternatives for travelling	Whenever I can, I prefer green alternatives while travelling (e.g. using public transport instead of taking the car or travelling by train instead of flying).	Ordinal
	P2Q3	Energy consumption	I try to keep my energy consumption for heating and electricity as low as possible.	Ordinal
	P2Q4	Diet change	I changed my diet for environmental reasons (e.g. eating less meat or choosing a vegetarian/vegan diet).	Ordinal
	P2Q5	Concern with environmental issues	I think of myself as someone who is very concerned with environmental issues.	Ordinal
	P2Q6	Importance of climate change	Climate change is one of the most important issues of humanity and needs to be acted upon immediately.	Ordinal
Part III: Consumers' knowledge regarding product carbon footprints and life-cycle-assessments	P3Q1	Ecological footprint	I know what an ecological footprint is.	Dichotomous
	P3Q2	Calculation ecological footprint	I have calculated my ecological footprint before.	Dichotomous
	P3Q3	Product carbon footprint	I have heard of product carbon footprints before.	Dichotomous

	P3Q4	Life-cycle-assessment	I have heard of life-cycle-assessments before.	Dichotomous
	P3Q5	Describe product carbon footprint	I can describe what a product carbon footprint is.	Ordinal
	P3Q6	Describe life-cycle-assessment	I can describe what a life-cycle-assessment is.	Ordinal
	P3Q7	Impact of adjustment of food consumption habits	Adjusting food consumption habits can have a substantial impact on global greenhouse gas emissions.	Ordinal
	P3Q8	Factors of the emissions of food	Please list three factors that you think contribute the most to the emissions caused by grocery products. Try to use only one word for each answer. If you can't think of three factors, please leave the other answer options empty.	Nominal
Part IV: Consumers' needs for a label in order to close knowledge gaps	P4Q1	Importance of communication of information	I think communication of this information is important for a product carbon footprint label to be useful.	Ordinal
	P4Q2	Understandable by anyone	I think this information can be understood by anyone if communicated well.	Ordinal
	P4Q3	Direct communication through label	This kind of information should be communicated directly through the label.	Ordinal
	P4Q4	Separate provision of information	This kind of information should be provided separately (e.g. on a website linked to by the label).	Ordinal
	P4Q5	Simple or detailed information	This kind of information should be simplified as much as possible/this kind of information should be explained in detail to make it comprehensible.	Ordinal
Part V: Consumers' preferences for design criteria	P5Q1	Visual guidance tool	A visual guidance tool should be included, comparable with a traffic light (e.g. a	Ordinal

concerning a product carbon footprint label			colour code with red indicating more harmful products, yellow indicating moderately harmful product and green indicating the least harmful products).	
	P5Q2	Simple or detailed design	The label should have a simple design for quick comparison in the store/the label should have a more detailed design with more information directly at hand.	Ordinal
	P5Q3	Total amount of CO_2e	The label should contain total numbers of CO_2e (e.g. “this product has caused the emissions of 300g CO_2e”).	Ordinal
	P5Q4	Comparison within product category	The label should allow for comparison within a product category (e.g. for comparing different brands of fruit juice).	Ordinal
	P5Q5	Comparison between product categories	The label should allow for comparison between different product categories (e.g. for comparing vegetables with dairy products).	Ordinal
	P5Q6	Simple design with QR-code	The label should have a simple design including a QR-code that leads to a website with more detailed information.	Ordinal
Part VI: Consumers’ needs for incentives/boosts to buy lower carbon footprint products	P6Q1	Influence of label	A product carbon footprint label would influence my buying decisions.	Ordinal
	P6Q2	Willingness to pay more for low carbon products	I would be willing to pay more money for product alternatives with a lower carbon footprint.	Ordinal
	P6Q3	Factors for choosing low carbon products	Which factors would make you choose a low carbon product when you have several to	Nominal

			choose from? Please list three factors below. Try not to use more than three words for each answer. If you can't think of three factors, please leave the other answer options empty.	

Questions and structure of survey

Introduction text

Welcome to this survey!

Dear participants,

Thank you for your interest in this study. It will take approximately 10-15 minutes to complete. It is part of the data collection for a bachelor thesis on consumer perception. The subject of the survey will be revealed step by step in order to prevent biased answers. There is no previous knowledge required in order to complete it. Nonetheless, it is essential for the results of the study, that you read the questions carefully and answer honestly. There is no right or wrong, please chose the answers that comes closest to your perspective. The data will be collected anonymously. All participants have the right to withdraw their entry from the survey until it ends in approximately two weeks.

All participants are invited to enter for a chance to win one of 5 Amazon gift cards worth 10€ each at the end of the survey. Note that you can only win one of the gift cards, if you completed the survey with valid answers.

Responsible for the survey is Jonathan Szabo [redacted], student of the Leuphana University of Lüneburg (Faculty of Sustainability). The bachelor thesis is supervised by Prof. Dr. Paul Upham and Karoline Pöggel.

Part I: Demographics

Please check the answers that apply to you.

1. Age Range
    a. Under 18
    b. 18-29
    c. 30-44
    d. 45-59
    e. 60-74
    f. 75 or over
2. Gender
    a. Female
    b. Male
    c. Diverse
3. Occupation
    a. Student
    b. In apprenticeship
    c. Looking after home or family

    d. Employed
    e. Self-Employed
    f. Unemployed/Looking for work
    g. Retired
4. Country of Residence
    a. “blank filler”

Part II: Participants’ environmental attitude and behaviour

Please read the following statements and select the answer that fits you the best (1 – strongly disagree; 5 strongly agree).

1. The environmental performance of a product is an important criterion for me when shopping for groceries.

2. Whenever I can, I prefer green alternatives while travelling (e.g. using public transport instead of taking the car or travelling by train instead of flying).

3. I try to keep my energy consumption for heating and electricity as low as possible.

4. I changed my diet for environmental reasons (e.g. eating less meat or choosing a vegetarian/vegan diet).

5. I think of myself as someone who is very concerned with environmental issues.

6. Climate change is one of the most important issues of humanity and needs to be acted upon immediately.

Part III: Consumers’ knowledge regarding product carbon footprints and life-cycle-assessments

The next set of statements aims to test the participants’ **prior** knowledge about the subject of this study. Please answer honestly to help this study produce valuable results. Please read the following statements and answer depending if they are true or false for you (yes; no).

1. I know what an ecological footprint is.

2. I have calculated my ecological footprint before.

3. I have heard of product carbon footprints before.

4. I have heard of life-cycle-assessments before.

Please read the following statements and select the option that fits the statement the best on a scale from 1-5.

5. I can describe what a product carbon footprint is. (1 – can’t describe at all; 5 can describe perfectly)

6. I can describe what a life-cycle-assessment is. (1 – can’t describe at all; 5 can describe perfectly)

7. Adjusting food consumption habits can have a substantial impact on global greenhouse gas emissions. (1 – strongly disagree; 5 strongly agree)

8. Please list three factors that you think contribute the most to the emissions caused by grocery products. Try to use only one word for each answer. If you can't think of three factors, please leave the other answer options empty. (three blank options)

Part IV: Consumers' needs for a label in order to close knowledge gaps

The following text passage provides some information on product carbon footprints and life-cycle-assessments. Please read it carefully, as it helps you to continue with the survey.

Regardless of whether you already heard of product carbon footprints and life-cycle-assessments, it is a complex subject with a lot of different research going into it. In general, "[t]he product carbon footprint is a measure of the climate change impact of the product where all the greenhouse gas emissions emitted during the product life cycle are taken into account" (Hartikainen et al., 2013). The reference unit is usually CO_2, meaning that the equivalent for the impact of other greenhouse gases like methane is calculated and expressed in numbers of CO_2e (or CO_2eq).
In order to identify as much of the emissions caused by a product as possible, a life-cycle-assessment is a helpful method. Just like the different stages in the life-cycle of a butterfly (the egg, the larva, the caterpillar, the chrysalis and the butterfly), a product made by humans also has different stages in its life cycle. From obtaining everything needed to make the product, through manufacturing it, using it and finally deciding what happens to it after its usage, these different stages need to be included when calculating the emissions caused (Matthews et al., 2014).
All products have different life cycles and each product has its own carbon footprint. Due to the complexity of the life cycles, the extend of such an assessment needs to be clearly communicated through the definition of the boundaries. Only then the results of the assessment can be compared and translated into valuable statements about a product.
Since it is nearly impossible for consumers to know the life-cycle of every product that they are buying, let alone their emissions, product carbon footprint labelling aims to educate them about the products and to help them make more informed decisions. Theoretically, these labels could be displayed on a product like a fair-trade label. It provides the consumer with information about the carbon footprint of a product and whether a product is more or less harmful for the environment than others.

The following statements serve the purpose to find out how such a label displayed on grocery items can help you to understand these concepts in order to enable you to make use of the label. The information referred to is provided by the preceding text. Please read the following statements and select the option that fits the statement the best on a scale from 1-5.

1. I think communication of this information is important for a product carbon footprint label to be useful. (1 – strongly disagree; 5 strongly agree)

2. I think this information can be understood by anyone if communicated well. (1 – strongly disagree; 5 strongly agree)

3. This kind of information should be communicated directly through the label. (1 – strongly disagree; 5 strongly agree)

4. This kind of information should be provided separately (e.g. on a website linked to by the label). (1 – strongly disagree; 5 strongly agree)

5. This kind of information should be simplified as much as possible/this kind of information should be explained in detail to make it comprehensible. (1 – as simplified as possible; 5 as detailed as possible)

Part V: Consumers' preferences for design criteria concerning a product carbon footprint label

The next section focusses on the visual design of a label. Please look at the following possible design criteria of a product carbon footprint label and evaluate them on a scale from 1-5 regarding on whether you think that they are helpful and valuable for you or not.

1. A visual guidance tool should be included, comparable with a traffic light (e.g. a colour code with red indicating more harmful products, yellow indicating moderately harmful product and green indicating the least harmful products). (1 – not valuable at all; 5 – very valuable)

2. The label should have a simple design for quick comparison in the store/the label should have a more detailed design with more information directly at hand. (1 – very simple design; 5 – very detailed design)

3. The label should contain total numbers of CO_2e (e.g. "this product has caused the emissions of 300g CO_2e"). (1 – not valuable at all; 5 – very valuable)

4. The label should allow for comparison within a product category (e.g. for comparing different brands of fruit juice). (1 – not valuable at all; 5 – very valuable)

5. The label should allow for comparison between different product categories (e.g. for comparing vegetables with dairy products). (1 – not valuable at all; 5 – very valuable)

6. The label should have a simple design including a QR-code that leads to a website with more detailed information. (1 – not valuable at all; 5 – very valuable)

Part VI: Consumers' needs for incentives/boosts to buy lower carbon footprint products

This part aims to evaluate the effect that a product carbon footprint label could have on consumers' buying decisions and behaviour. To answer the final part of this survey, please try to imagine an ideal product carbon footprint label. It should contain all the information that you need to understand it and it should be visually designed in a way, that appeals you the most. With that in mind, please read the following statements and select the answer that you think fits you the best (1 – strongly disagree; 5 strongly agree).

1. A product carbon footprint label would influence my buying decisions.

2. I would be willing to pay more money for product alternatives with a lower carbon footprint.

3. Which factors would make you choose a low carbon product when you have several to choose from? Please list three factors below. Try not to use more than three words for each answer. If you can't think of three factors, please leave the other answer options empty. (three blank options)

Participation in raffle for gift cards

You finished the survey.

Thank you for participating! If you are interested in the results of this study, the thesis can be reviewed in the library of the Leuphana University of Lüneburg once it is published.

If you want to pursue your chance of winning one of the 5x10€ Amazon gift cards, please enter your email-address below. The winners will be picked randomly from all successful submissions. Your email-address will only be used for the purpose of selecting the winners. It will not be published or shared with third parties. The winners will receive an email with the code of a gift card. After all winners received their price, the email-addresses will be deleted. Please click the submit button (or "Absenden") to finish the survey.

3 Complete answers of the survey

ID	P1Q1	P1Q2	P1Q3	P1Q4	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P3Q1	P3Q2	P3Q3	P3Q4	P3Q5	P3Q6	P3Q7	P3Q8[SQ001]	P3Q8[SQ002]	P3Q8[SQ003]
1	18-29	Female	Student	Germany	5	5	5	5	5	5	Yes	Yes	Yes	Yes	4	4	5	Change of land use	Transport	Livestock farming
2	18-29	Female	Student	Germany	5	5	5	5	5	5	Yes	Yes	Yes	Yes	5	5	5	Animal origin	Air transport	Long cooling
4	18-29	Male	Student	Germany	2	4	5	1	2	5	Yes	No	Yes	No	4	1	2	Grazing	NA	NA
7	18-29	Female	Student	Germany	3	3	2	3	4	5	Yes	Yes	Yes	No	3	1	4	Fertilizer	Plant protection products	Monocultures
8	18-29	Female	Student	Germany	5	4	2	5	4	4	Yes	Yes	Yes	Yes	4	4	4	Transport	Production	Disposal
10	18-29	Male	Student	Germany	2	4	1	2	3	5	Yes	Yes	Yes	No	4	1	4	Transport	Factory farming	Deforestation
11	18-29	Female	In apprenticeship	Germany	2	4	4	2	3	4	Yes	Yes	Yes	No	4	1	4	Meat industry	Oversea products	NA
12	18-29	Male	Student	Germany	4	2	3	1	2	3	Yes	No	No	No	2	3	4	Transport routes	Packaging	NA
13	18-29	Female	Student	Germany	4	4	4	5	4	5	Yes	Yes	Yes	No	5	1	5	Transport routes	Livestock farming	Packaging
14	18-29	Female	In apprenticeship	Germany	2	4	3	2	3	2	Yes	Yes	Yes	No	3	1	5	Meat	Milk	NA
16	18-29	Male	Student	Germany	3	3	4	2	3	4	Yes	No	Yes	Yes	5	4	4	Livestock farming	Oil	NA
17	18-29	Female	Student	Germany	4	4	3	4	3	4	Yes	Yes	Yes	No	3	1	4	Industry	Agriculture	NA
18	45-59	Male	Employed	Germany	3	2	3	3	4	5	Yes	No	Yes	No	3	1	5	Meat consumption	Long transport routes	Factory farming
19	18-29	Female	Student	Germany	4	4	3	5	4	5	Yes	Yes	Yes	Yes	3	3	5	Meat production	Transport	Not seasonal
20	Under 18	Male	Student	Germany	3	4	4	4	2	4	Yes	No	Yes	No	2	1	4	NA	NA	NA
21	18-29	Female	In apprenticeship	Germany	1	4	4	5	5	5	Yes	No	No	No	1	1	5	Meat production	Plastic packaging	Mass production
23	60-74	Male	Self-Employed	Germany	3	2	5	3	3	5	No	No	No	No	1	1	3	Livestock farming	Factory	NA
24	18-29	Male	Student	Germany	4	2	4	4	3	5	Yes	No	Yes	No	4	1	5	Distance	Packaging	Pesticides
25	18-29	Female	Student	Germany	5	5	3	5	5	5	Yes	Yes	Yes	Yes	4	3	4	Land use	Transport	Processing
26	18-29	Female	Student	Germany	4	4	5	5	4	5	Yes	Yes	Yes	No	4	1	5	Transport	Water consumption	Space for cultivation (Clearing)
27	18-29	Male	Employed	Germany	3	5	4	5	4	5	Yes	Yes	Yes	Yes	5	5	5	Factory farming	Transport	Packaging
28	18-29	Male	Student	Germany	1	1	1	1	5	5	Yes	Yes	Yes	No	5	1	1	NA	NA	NA
29	18-29	Female	Student	Germany	5	5	4	5	5	5	Yes	Yes	Yes	Yes	5	3	5	Animal products	Transport routes	Packaging waste
30	18-29	Male	Looking after home or family	Germany	2	2	5	1	3	5	Yes	No	Yes	Yes	4	3	5	Livestock farming	NA	NA
31	18-29	Female	Student	Germany	3	5	4	5	5	4	Yes	Yes	Yes	Yes	3	3	3	Grocery processing	Storage	Packaging
32	18-29	Female	Student	Germany	4	5	4	5	5	5	Yes	Yes	Yes	Yes	4	3	5	Livestock farming	Forest clearing	Transport
33	18-29	Female	Student	Germany	4	3	4	4	5	5	Yes	Yes	Yes	Yes	5	5	4	Agriculture	Transport	Packaging
35	45-59	Female	Employed	Germany	4	2	5	5	3	4	Yes	No	Yes	No	2	1	4	Production	Packaging	Transport
36	18-29	Female	Student	Germany	3	4	2	4	4	5	Yes	No	No	Yes	3	2	4	Meat production	Transport	NA
38	18-29	Female	Student	Germany	4	3	5	4	3	5	Yes	Yes	Yes	No	3	1	4	Transport routes	Energy sources	Routes of employees
39	18-29	Male	Student	Germany	1	2	3	2	2	1	Yes	Yes	Yes	Yes	3	4	4	Livestock farming	Transport	NA
41	18-29	Female	Student	Germany	5	4	4	5	5	5	Yes	Yes	Yes	Yes	4	4	4	Meat production	Tranport emissions	Greenhouses
43	45-59	Female	Employed	Germany	3	4	5	3	2	4	Yes	No	Yes	No	4	1	4	Beef	NA	NA
44	60-74	Male	Self-Employed	Germany	2	1	5	3	4	5	Yes	No	Yes	Yes	4	3	5	Demand	Price pressure	Globalisation
46	18-29	Female	Employed	Germany	3	3	3	3	3	3	Yes	No	Yes	Yes	3	3	2	NA	NA	NA
50	60-74	Female	Employed	Germany	5	4	5	4	5	5	Yes	No	Yes	No	4	1	5	Transport routes	Cultivation	Livestock farming
52	45-59	Female	Employed	Germany	3	3	4	3	4	5	Yes	No	Yes	No	3	1	4	Production location	Transport	Storage
53	18-29	Male	Student	Denmark	3	2	5	5	4	5	Yes	Yes	Yes	Yes	4	4	5	Transport	Animal food	Deforestation
54	75 or over	Female	Retired	Germany	5	5	5	3	5	5	Yes	No	Yes	No	3	1	5	Overproduction	NA	NA
57	18-29	Female	Employed	Germany	3	2	1	3	2	2	Yes	Yes	Yes	No	3	1	3	NA	NA	NA
58	18-29	Female	Student	Germany	4	3	4	4	4	4	Yes	Yes	Yes	No	3	1	5	Livestock farming	Transport routes	NA
59	18-29	Female	Student	Germany	4	3	4	4	3	4	Yes	Yes	Yes	No	4	1	5	Meat industry	Packaging (plastic)	Import/Export
60	18-29	Male	Self-Employed	Germany	2	1	4	5	5	1	Yes	No	No	No	1	1	5	Production	Storage	Transport

ID	P4Q1	P4Q2	P4Q3	P4Q4	P4Q5	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P6Q1	P6Q2	P6Q3[SQ001]	P6Q3[SQ002]	P6Q3[SQ003]
1	3	4	NA	NA	NA	1	5	3	5	1	1	4	5	NA	NA	NA
2	5	3	3	4	2	4	5	5	4	5	5	3	4	Comparable products	Lower CO2 footprint	Proportional price difference
4	5	5	3	3	2	4	NA	5	2	2	5	3	3	NA	NA	NA
7	5	3	4	3	2	4	5	3	5	4	3	4	3	Not too expensive	Also sustainable in other ways	NA
8	5	5	4	3	2	4	2	3	4	4	3	4	4	Protection of the environment	NA	NA
10	5	5	2	5	1	4	2	4	4	1	4	5	4	Colour code	Scale	Comparison
11	3	4	4	3	3	4	3	2	4	3	3	4	4	Comparable quality	Moderate price	Regional
12	4	4	2	4	4	4	2	2	4	2	4	4	3	NA	NA	NA
13	5	5	5	2	2	5	2	2	4	4	5	4	2	Same product category	No quality loss	No extreme price difference
14	5	4	5	4	5	5	1	2	3	3	4	3	4	Environment	Climate	NA
16	4	5	5	3	1	3	1	3	5	2	5	4	4	CO2 Footprint	Price	Taste
17	3	3	4	3	2	5	4	3	4	4	2	5	4	Livestock more important than CO2	Significant higher price	NA
18	5	5	5	1	2	5	2	2	3	3	2	5	5	Price	Origin	NA
19	4	5	4	2	1	5	2	4	4	3	5	5	4	Similar price	Similar quality	Environmentally friendly packaging
20	5	4	3	4	3	5	2	2	4	2	5	4	3	Not much more expensive	NA	NA
21	5	5	5	3	3	5	3	2	2	1	5	5	5	Protein content	Low sugar	Fresh products
23	2	4	1	5	2	5	2	1	1	3	4	5	4	Protection of the environment	Future of children	Saving the earth
24	5	4	5	2	1	5	1	2	4	1	2	4	4	NA	NA	NA
25	3	4	3	5	2	5	4	4	4	4	5	5	4	Proportionality of price	Quality	Taste/Functionality
26	5	4	4	4	5	3	3	4	4	3	4	5	5	Quality	NA	NA
27	5	5	NA		3	3	5	3	2	5	2	5	5	NA	NA	NA
28	4	3	2	4	2	5	5	2	2	2	5	1	1	Must taste good	NA	NA
29	5	5	5	5	5	5	5	5	5	5	5	5	5	Responsibility	Protection of climate	Conscience
30	3	5	4	2	1	5	1	1	5	3	5	3	3	Moderate price differences	NA	NA
31	4	4	4	1	5	4	4	2	5	3	4	4	3	NA	NA	NA
32	5	5	5	2	3	5	3	5	4	4	5	5	5	Knowledge about CO2 footprint	Appetising appearance	Price
33	4	4	4	3	2	5	3	4	5	4	5	4	5	Low price	More sustainable in comparison	Tastes well
35	4	3	4	2	1	5	3	4	5	5	5	4	3	No higher price	Better quality	High CO2 saving
36	5	5	5	1	3	5	3	5	5	2	5	5	5	Knowledge to help	Steer market through consumption in sustainable direction	Inspire others to think about their consumption
38	5	5	3	5	3	5	2	5	3	2	5	NA	5	Better conscience	Reduction of knowledge-action-gap	Contribution to fight against climate change
39	3	4	1	5	1	5	1	2	2	3	5	4	4	Price	CO2 footprint	Origin
41	4	5	3	3	3	2	2	4	4	4	4	4	4	Same or lower price	Eco-fair production	Conscience
43	4	4	4	4	2	4	3	2	3	5	5	4	4	Recognisability	NA	NA
44	1	1	1	4	1	5	5	1	5	1	3	4	4	Promotion of sustainable production	Promotion of regional suppliers	Promotion of non-industrial production
46	NA	NA	NA	NA	NA	5	5	3	4	3	5	4	4	Information	Comparison	Good alternatives
50	5	5	5	2	3	5	3	NA	4	2	4	5	5	Better eco-balance	Regional	NA
52	5	5	4	2	2	2	2	2	4	2	5	3	4	Local provider	Quality of product	NA
53	5	4	4	1	5	5	4	1	5	2	1	5	4	Easy comparison within product category	Total effect of product on my CO2 footprint	NA
54	5	5	5	2	2	5	5	1	5	5	5	5	5	Sustainability	NA	NA
57	4	5	5	2	5	5	5	3	4	3	4	4	4	NA	NA	NA
58	4	5	4	2	4	4	2	2	4	4	3	4	4	Small financial difference	Tastes well	Packaging design
59	4	5	4	2	2	4	2	4	4	5	4	5	5	Quality	Price performance	Protection of environment
60	5	5	1	5	3	5	5	1	4	1	5	5	5	CO2 Footprint	NA	NA

ID	P1Q1	P1Q2	P1Q3	P1Q4	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P3Q1	P3Q2	P3Q3	P3Q4	P3Q5	P3Q6	P3Q7	P3Q8[SQ001]	P3Q8[SQ002]	P3Q8[SQ003]
61	18-29	Female	Student	Germany	3	4	4	3	2	4	Yes	Yes	Yes	Yes	3	3	5	Transport	Packaging	Production
62	18-29	Female	Student	Germany	3	2	3	3	4	4	Yes	Yes	No	Yes	2	2	4	Transport	Packaging	Production
63	45-59	Female	Self-Employed	Germany	4	4	4	4	5	5	Yes	No	Yes	No	3	1	5	Grocery/Animal transport	Factory farming	Deforestation
64	30-44	Female	Employed	Germany	4	1	3	4	4	4	Yes	No	Yes	No	2	1	3	Methane	Plastic	Transport routes
65	30-44	Female	Self-Employed	Germany	3	3	2	4	4	5	Yes	Yes	Yes	Yes	4	4	5	Transport	Forest clearing	Soil changes
67	18-29	Female	Student	Germany	4	2	5	4	3	4	Yes	Yes	No	No	4	1	4	Transport	Mass production	NA
68	18-29	Female	Student	Germany	4	4	3	5	3	3	Yes	Yes	Yes	Yes	4	4	4	Land use	Transport	Packaging
69	18-29	Female	Student	Germany	5	1	2	5	1	5	Yes	No	Yes	Yes	4	4	5	Transport	Factory farming	Amazon fires
70	18-29	Female	Student	Germany	3	1	4	1	3	1	Yes	Yes	Yes	Yes	4	4	3	Meat	Coffee	Soy
71	18-29	Male	Employed	Germany	4	1	3	3	4	4	Yes	No	Yes	No	3	3	4	Long transport routes	Water consumption	NA
72	18-29	Female	Student	Germany	5	5	5	5	5	5	Yes	Yes	Yes	Yes	5	5	5	Agricultural production (especially beef and greenhouses)	Transport (depending on way of transport)	Lost CO2 storage through deforestation
73	75 or over	Female	Retired	Germany	3	3	5	4	3	4	Yes	No	No	No	2	1	4	Factory farming	Industrialisation of agriculture	Packaging
74	45-59	Male	Employed	Germany	2	4	1	2	3	2	Yes	No	Yes	Yes	4	4	2	Overproduction	Unecological consumption	Ways of production in China
75	30-44	Female	Employed	Germany	4	3	3	3	4	4	Yes	Yes	Yes	No	3	1	5	Raw material extraction	Production	Transport
76	18-29	Female	Student	Germany	4	4	3	3	2	2	Yes	Yes	Yes	No	3	1	2	Cheap products	Waste of groceries	Meat consumption
77	18-29	Male	Student	Germany	3	2	4	3	4	5	Yes	Yes	Yes	NA	4	4	5	Meat consumption	NA	NA
78	75 or over	Male	Retired	Germany	4	3	5	3	4	5	Yes	No	Yes	No	3	1	3	Factory farming	Waste society	Overpopulation
79	30-44	Male	Employed	Germany	3	2	1	1	4	4	Yes	No	Yes	No	4	1	4	Transport	Fertilizer	Packaging
81	18-29	Female	Employed	Germany	2	2	2	3	5	5	Yes	No	Yes	Yes	3	1	3	Transport	Fertilizer	Packaging
84	18-29	Male	Employed	Germany	3	2	4	4	2	4	Yes	No	Yes	No	4	1	4	Meat	Transport	Choice of groceries
85	45-59	Female	Self-Employed	Germany	3	3	4	4	4	4	Yes	No	Yes	No	4	1	5	Factory farming	Eating and buying too much meat	NA
86	45-59	NA	Employed	Germany	5	3	3	3	3	3	No	No	No	No	1	1	4	NA	NA	NA
88	30-44	Female	Employed	Germany	5	2	5	2	4	5	Yes	No	Yes	No	3	1	4	Plastic	Factory farming	Transport
89	30-44	Female	Employed	Germany	4	2	3	5	2	2	Yes	No	No	No	1	1	3	Waste of water	Transport routes	Habitat destruction
91	30-44	Female	Employed	Germany	4	1	5	2	4	5	Yes	No	No	No	1	1	3	Transport	Energy for production (greenhouse)	NA
92	30-44	Female	Employed	Germany	5	4	5	4	4	5	Yes	Yes	Yes	No	4	1	4	Factory farming	Greenhouses is low-water areas	Monocultures
93	18-29	Male	Student	Germany	4	4	2	5	2	5	Yes	Yes	Yes	Yes	5	5	3	Nutrition	Transport	Industry
97	30-44	Male	Employed	Germany	5	5	4	4	3	5	Yes	Yes	Yes	No	4	1	5	Transport	Packaging	Disposal
98	18-29	Female	Employed	Germany	4	2	2	2	3	3	Yes	No	Yes	No	4	1	4	Meat consumption	Consumption of milk	NA
99	45-59	Male	Employed	Germany	4	4	5	3	5	5	Yes	No	Yes	No	4	1	3	Methane from dairy cattle farming	Clearing for palm oil	Deforestation for soy cultivation
100	45-59	Male	Employed	Germany	3	3	4	4	4	5	Yes	No	Yes	No	3	2	4	Factory farming	Transports	Pesticides
101	18-29	Male	Student	Germany	4	3	4	4	5	5	Yes	Yes	Yes	Yes	5	3	4	Transport	Production	Feed
102	18-29	Female	Student	Germany	3	3	3	2	3	4	Yes	Yes	Yes	No	4	2	3	Long transport routes	Maintenance of grenhouses	Meat production
103	18-29	Female	Student	Germany	2	3	2	3	4	5	Yes	Yes	Yes	No	4	1	4	Meat eaters	Transport routes	NA
104	18-29	Female	Student	Germany	3	3	4	1	2	5	Yes	Yes	No	Yes	2	1	5	Storage	Production	NA
105	18-29	Female	Unemployed/Looking for work	Germany	3	4	3	5	5	5	Yes	Yes	No	Yes	2	2	5	Cattle farming	NA	NA
106	18-29	Female	Student	Germany	5	5	4	5	4	5	Yes	Yes	Yes	Yes	3	3	5	Transport	Production expenditures	Group of groceries
107	18-29	Male	Student	Germany	4	3	1	4	5	5	Yes	NA	Yes	Yes	4	3	2	Excrements	Feed	Transport
108	18-29	Female	Student	Germany	2	2	1	3	3	5	Yes	Yes	Yes	No	5	1	3	Production	Transport	NA
110	18-29	Male	Student	Germany	1	4	4	1	4	5	No	No	No	No	1	1	3	Production	Transport	Disposal
111	60-74	Female	Retired	Germany	4	2	4	4	4	5	Yes	No	Yes	No	3	1	5	Livestock farming	Palm oil	Monocultures
113	30-44	Female	Employed	Germany	5	5	4	4	3	3	Yes	Yes	Yes	Yes	4	4	5	Agriculture	Industry	Transport and logistics of products
114	30-44	Female	Employed	Germany	3	4	5	3	4	5	Yes	Yes	Yes	No	4	1	4	Transport	Form of production	Cultivation (Food)

ID	P4Q1	P4Q2	P4Q3	P4Q4	P4Q5	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P6Q1	P6Q2	P6Q3[SQ001]	P6Q3[SQ002]	P6Q3[SQ003]
61	5	3	5	2	2	5	1	3	4	2	2	5	5	Not too expensive	Label is trustworthy	Convincing label
62	5	4	2	4	2	5	2	4	4	2	5	4	3	Taste	Similar price	NA
63	5	4	5	1	1	4	3	3	5	2	5	5	5	Quality	Affordable price	Transparency of content, organic, CO2
64	4	2	5	1	1	5	1	1	5	3	4	5	5	Regional	Production	Taste
65	3	4	2	4	2	4	2	2	5	2	4	5	4	Price	Quality	Belief
67	4	5	4	1	1	5	2	2	4	2	4	4	4	NA	NA	NA
68	5	4	3	2	1	4	1	2	5	5	4	5	4	Comparable product	Comparable price	Good design
69	5	5	5	2	1	4	4	3	5	4	5	5	4	Appropriate price	Appealing design	NA
70	4	4	4	4	1	4	1	1	5	5	5	4	4	Regional	NA	NA
71	5	4	5	2	2	4	1	4	4	4	4	4	4	Transparent information for decision	Equivalent alternative	Local product
72	5	5	3	5	3	5	3	5	5	5	5	4	4	Appropriate price	Fair-trade	Organic/ecological
73	5	5	5	1	1	5	1	2	3	3	5	4	5	Organic	Regional	Fresh
74	4	2	2	3	5	5	5	2	4	1	5	1	2	Proven effect on eco-balance	Contribution of my buying decision for sustainability	Price-performance-ratio
75	5	5	4	4	3	5	3	5	5	3	5	4	4	At least same quality	Acceptable price-performance-ratio	NA
76	2	3	2	2	2	5	1	5	5	2	3	5	5	NA	NA	NA
77	4	4	4	3	3	4	3	3	3	3	4	3	3	Affordable price	NA	NA
78	5	4	5	1	3	4	2	2	4	3	2	3	3	Known brand	Regional product	Price
79	5	4	3	5	3	5	2	5	4	4	4	5	5	Taste	Regional production	Quality
81	5	4	4	3	2	5	3	4	4	4	5	4	4	NA	NA	NA
84	5	5	5	5	3	4	3	5	5	2	5	4	4	Origin	Husbandry/Production	Sustainability
85	4	3	4	2	4	5	5	4	5	4	5	4	3	NA	NA	NA
86	3	3	3	3	3	3	3	3	3	3	3	3	3	NA	NA	NA
88	5	5	3	4	5	5	1	1	4	1	5	4	4	Transparency	Broad acceptance of the producer	Reasonable additional costs
89	5	2	5	2	1	5	1	2	2	3	5	5	5	Protect water resources	Save habitats of endangered species	Low emissions
91	5	5	5	1	1	5	1	2	5	1	5	5	5	Low CO2 emissions	Less waste	Promotion of regionality
92	NA		5	3	3	5	4	5	5	5	5	4	5	NA	NA	NA
93	4	3	4	1	4	5	5	4	5	4	3	5	4	Comparability	Simplicity	NA
97	5	3	5	2	5	5	1	5	5	5	2	5	5	Transparency	Quality	Price
98	5	5	5	1	2	5	2	3	5	3	3	5	5	Price is realistic	Product has quality	NA
99	5	3	4	3	3	5	3	2	5	4	5	5	5	CO2 mitigation measures	Information content	Price
100	5	5	5	2	2	5	2	5	3	1	4	4	4	Reduction of emissions	Own engagement	Improvement of climate
101	5	4	5	1	3	1	4	5	4	1	1	4	4	Same price as other products	Large difference of CO2	Same quality
102	4	4	NA		3	3	3	4	3	4	2	4	3	4 Clear communication	Not much more expensive	NA
103	4	5	5	2	1	5	1	3	4	1	3	4	4	Price performance	Good conscience	No other choice
104	4	5	4	1	1	3	2	1	4	2	1	5	3	Differences of CO2 footprints	Price	NA
105	4	5	4	2	3	5	1	4	5	2	2	5	4	NA	NA	NA
106	4	3	4	2	2	5	2	4	5	5	5	5	4	Price	Regional, seasonal, organic	Not a lot of packaging
107	5	5	5	5	5	4	NA		5	5	5	5	5	4 Complete transparency	Low costs	NA
108	5	5	5	1	4	5	3	3	5	5	4	5	5	Work conditions better than "competition"	Price	Quality
110	5	5	5	3	5	3	1	3	5	4	4	3	2	Price	Availability	NA
111	5	5	5	1	5	5	5	4	4	4	2	4	4	Comprehensibility	NA	NA
113	5	5	5	1	4	5	5	3	2	2	1	4	3	Quality	Price	Other product characteristics
114	5	3	5	5	5	5	5	4	5	3	5	3	4	Conscience	NA	NA

ID	P1Q1	P1Q2	P1Q3	P1Q4	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P3Q1	P3Q2	P3Q3	P3Q4	P3Q5	P3Q6	P3Q7	P3Q8[SQ001]	P3Q8[SQ002]	P3Q8[SQ003]
115	18-29	Female	Student	Germany	4	4	5	4	4	4	Yes	Yes	Yes	Yes	4	3	5	Waste of groceries	Trust in liberal markets	Long transport routes
116	18-29	Female	Student	Germany	5	5	4	3	2	4	Yes	Yes	Yes	Yes	3	2	3	Electricity	Clearing	Methane
117	18-29	Female	Student	Germany	4	4	2	4	4	5	Yes	Yes	Yes	No	4	2	5	Consumption of animal products	Transport	Clearing of (rain-)forest
119	18-29	Male	Student	Germany	4	4	3	2	3	4	Yes	Yes	Yes	No	5	3	3	Animal food production	Transport	NA
121	30-44	Female	Student	Germany	5	4	4	3	4	5	Yes	Yes	Yes	Yes	4	4	5	Meat	Transport	Too much fertilizer
122	18-29	Female	Student	Germany	4	5	4	5	4	5	Yes	Yes	Yes	No	4	2	4	Cultivation/Production	Transport	Consumption
123	30-44	Female	Student	Germany	2	3	3	5	2	2	Yes	Yes	Yes	Yes	1	1	NA	Waste of groceries	Livestock farming (Methane)	Fertilizer for agriculture
125	18-29	Female	Student	Germany	5	4	4	5	4	5	Yes	Yes	NA	No	5	1	5	Transport	Waste disposal	Pesticides
126	18-29	Female	Student	Germany	5	5	5	5	5	5	Yes	No	Yes	Yes	5	5	3	Meat consumption	Grassland ploughing	Greenhouses
128	45-59	Female	Employed	Germany	5	5	5	5	5	5	Yes	Yes	Yes	No	4	1	5	Transport routes	Water consumption	Energy consumption (greenhouses etc.)
129	18-29	Female	Student	Germany	3	2	5	5	5	5	Yes	Yes	No	No	4	1	5	Factory	Transport	Storage of products
130	18-29	Female	Student	Germany	2	2	4	3	4	5	Yes	No	Yes	Yes	3	1	4	Factory	Transport	Harvest
131	18-29	Female	Student	Germany	4	5	4	4	4	5	Yes	Yes	Yes	Yes	3	3	4	Factory farming	Long transport routes (Truck, Airplane)	Packaging production
132	18-29	Female	Student	Germany	5	4	5	4	4	5	Yes	Yes	Yes	No	4	1	5	Ways of production	Transport	Packaging
133	18-29	Male	Student	Germany	5	5	5	5	5	5	Yes	Yes	Yes	Yes	5	4	5	Fertilizer	Transport	Methane
134	18-29	Female	Student	Germany	5	5	4	5	4	5	Yes	Yes	Yes	Yes	4	4	5	Rainforest clearing	Transport	Monocultures
135	18-29	Female	Student	Germany	5	5	4	5	5	5	Yes	Yes	Yes	Yes	5	5	5	Animal origin	Transport	Way of production
136	18-29	Female	Student	Germany	3	4	5	4	4	5	Yes	Yes	Yes	No	4	2	2	Factory farming	Transport	Feed production
137	18-29	Female	Student	Germany	4	4	4	5	5	5	Yes	Yes	Yes	Yes	5	5	5	Energy consumption during production	for animal products: the animal from which the product is made	Land use and transport
138	18-29	Female	Student	Germany	4	5	5	4	4	4	Yes	Yes	Yes	Yes	4	2	5	Transport	Factory farming	NA
139	18-29	Female	Student	Germany	2	3	4	4	2	4	Yes	No	No	No	1	1	3	NA	NA	NA
141	18-29	Female	Student	Germany	4	5	4	5	4	5	Yes	Yes	Yes	Yes	5	4	5	Phosphate and nitrate fertilizer	Feed	Waste of food
142	18-29	Female	Student	Germany	4	4	4	4	4	4	Yes	Yes	Yes	No	4	1	4	Packaging	Air transport	Production outsourcing
144	18-29	Female	Student	Germany	3	3	4	5	4	4	Yes	Yes	Yes	No	4	1	5	Water consumption during cultivation	Required space for cultivation	Energy consumption for harvest/Processing
145	18-29	Female	Student	Germany	5	4	3	5	4	5	Yes	Yes	Yes	Yes	4	5	5	Transports	Production (conventional vs. organic vs. regenerative)	Waste of food
146	18-29	Female	Student	Germany	5	4	3	5	4	5	Yes	Yes	Yes	Yes	5	4	4	Origin	NA	NA
148	18-29	Male	Student	Germany	3	2	4	1	3	4	Yes	Yes	Yes	No	4	1	4	Excessive consumption	Waste of groceries	Factory farming
150	18-29	Female	Student	Germany	5	5	4	4	4	5	Yes	Yes	Yes	Yes	4	3	5	Livestock farming	Transportation	Waste
152	18-29	Female	Student	Germany	5	4	4	5	5	5	Yes	Yes	Yes	Yes	5	5	5	Cultivation	Food for livestock	Transport
153	18-29	Female	Student	Germany	5	4	4	5	5	5	Yes	Yes	Yes	Yes	3	3	5	Factory farming	Transport routes	Packaging production
154	18-29	Female	Student	Germany	1	1	4	1	1	3	Yes	Yes	Yes	Yes	4	2	1	Fire clearance for animal food	Fire clearance for livestock farming	Animal emissions
157	18-29	Male	Employed	Germany	5	4	4	4	4	5	Yes	Yes	Yes	Yes	5	4	4	Raw material production	Processing	Preparation
158	18-29	Female	Student	Germany	5	5	4	4	4	5	Yes	Yes	Yes	No	4	1	4	Transport	Livestock farming	Packaging
159	18-29	Female	Student	Germany	5	4	4	5	5	5	Yes	Yes	Yes	Yes	4	2	4	Reclamation of land (e.g. by clearing)	Cultivation ofthe fields	Transport of food
161	18-29	Male	Student	Germany	3	2	2	3	4	5	Yes	Yes	Yes	Yes	3	4	5	Waste of groceries	Precarious employment	Cooling
162	18-29	Male	Student	Germany	4	4	3	3	4	3	Yes	Yes	Yes	No	5	NA		1 Meat	Avocado	Bananas
164	18-29	Female	Student	Germany	3	4	3	4	3	5	Yes	Yes	Yes	No	4	1	3	Water consumption	Food for livestock	Emissions during delivery
165	18-29	Female	Student	Germany	3	2	3	1	3	4	Yes	No	Yes	No	4	1	4	Agriculture	Meat production	Fertilizer
168	18-29	Female	Student	Germany	4	3	4	4	5	5	Yes	Yes	Yes	Yes	5	4	5	Wasting	Meat	Animal products
169	18-29	Diverse	Student	Germany	5	5	4	5	5	5	Yes	Yes	No	No	3	2	5	Production	Transport	Packaging
170	18-29	Female	Student	Germany	5	5	3	5	5	5	Yes	Yes	Yes	No	4	2	5	Methane emitted by cows	Deforestation, e.g. for cultivation of soy	Transport routes
171	18-29	Female	Student	Germany	5	5	4	5	4	5	Yes	Yes	Yes	No	4	1	5	Water consumption	Processing	Transport routes
172	18-29	Female	Student	Germany	2	2	2	1	2	2	Yes	No	No	No	3	1	2	Meat	Fertilizer	Soy

ID	P4Q1	P4Q2	P4Q3	P4Q4	P4Q5	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P6Q1	P6Q2	P6Q3[SQ001]	P6Q3[SQ002]	P6Q3[SQ003]
115	4	2	3	2	2	4	2	5	3	3	5	4	5	Not much more expensive	Good quality	Also socially sustainable
116	2	5	2	5	3	5	1	4	5	3	4	5	5	NA	NA	NA
117	5	5	2	4	4	5	2	3	NA	2	4	4	5	Simple communication	NA	NA
119	5	4	5	3	4	4	2	4	5	2	4	4	4	Clear visibilty of CO2 amount	NA	NA
121	4	4	4	5	3	5	4	5	4	2	4	4	4	Taste	Functionality	Packaging
122	5	5	5	2	2	5	2	4	4	2	5	5	5	NA	NA	NA
123	1	4	2	4	1	1	1	4	3	3	4	5	5	No packaging	Price performance (in regard to environment)	NA
125	4	3	4	2	1	5	5	4	4	4	4	5	5	Price	NA	NA
126	2	3	4	4	5	5	5	1	5	5	3	1	1	Contextualisation of CO2 footprint in numbers of °C	NA	NA
128	4	4	5	1	5	4	5	4	4	4	3	4	4	Good conscience	Responsibility towards the environment	NA
129	5	5	3	4	2	5	2	4	5	3	4	5	5	Appropriate price	Regionality	Quality
130	4	4	3	4	2	5	1	4	5	3	4	4	3	Appropriate price	Regionality	Quality
131	4	5	4	2	3	4	3	3	5	4	5	4	4	Enables easy comparison	Product is healthy	Price-performance-ratio
132	5	4	2	4	3	5	1	4	5	5	5	5	5	Clear labelling	Availability	Comprehensibility of label
133	4	5	1	5	2	5	2	4	5	4	5	5	5	Price	Unambiguity	Comparability
134	4	4	4	3	1	5	3	2	4	4	4	4	5	NA	NA	NA
135	4	4	5	2	3	4	5	4	5	4	5	4	4	Environmental compatibility	Packaging	Price
136	4	4	4	1	1	5	1	2	5	2	4	3	4	Less than 150% price difference	Same quality	NA
137	5	5	5	2	1	5	2	5	4	1	3	5	5	Healthier ingredients	Ecological packaging	Taste convincing
138	4	4	4	3	2	5	2	3	4	2	5	4	4	NA	NA	NA
139	5	4	5	2	1	5	1	4	5	5	4	4	4	Regionality of products	NA	NA
141	4	4	5	3	2	5	2	4	4	4	5	5	5	Conscience	Information	NA
142	4	4	4	4	2	4	2	4	4	4	5	5	4	NA	NA	NA
144	3	3	4	2	4	4	3	4	4	5	5	4	3	Price	Quality	Working conditions better
145	4	3	4	3	3	5	4	4	4	5	5	4	4	Ingredients	Price	Benefit/ Do I really need the product?
146	4	5	5	4	3	5	2	4	4	5	5	5	4	NA	NA	NA
148	5	5	4	4	4	5	5	2	2	1	5	4	3	Price	Quality	NA
150	5	5	4	2	2	5	2	3	4	4	5	5	5	More eco-friendly	Price	NA
152	3	5	4	4	4	4	4	4	4	4	4	4	4	Price	Quality	Optical design
153	5	5	4	4	1	5	2	2	5	5	5	4	4	Other quality characteristics	Interchangeability	Taste
154	2	1	4	4	1	4	1	2	3	3	4	1	1	Lower price	Higher quality	Appropriate amount
157	4	4	2	4	5	5	5	3	4	4	5	5	4	Understandability of benefits for environment	Clear improvement compared to conventional products	NA
158	3	5	2	5	1	4	1	3	5	4	4	5	5	Better for climate	Support of this product/production	Conscience
159	5	5	4	5	3	5	3	5	5	5	5	5	5	Better awareness through visible information	NA	NA
161	5	5	1	5	4	5	5	5	2	3	5	3	3	Price	Other eco-labels	Cognitive dissonance
162	4	3	5	4	5	5	5	5	5	3	5	5	5	Price	Local	NA
164	4	3	2	4	2	4	2	2	3	3	5	4	4	NA	NA	NA
165	4	3	5	2	1	5	2	3	3	2	2	5	4	Additional other factors	Small price difference	Organic/fair-trade
168	5	4	5	5	5	5	1	2	5	5	5	5	4	NA	NA	NA
169	5	5	4	3	4	4	3	3	3	3	3	3	4	NA	NA	NA
170	4	4	5	2	2	4	2	2	4	5	5	4	4	NA	NA	NA
171	5	4	5	2	2	4	2	2	4	5	5	4	4	No large price difference	Organic	Similar quality
172	1	2	4	4	2	1	1	4	1	4	1	1	1	Quality	Sustainable	Healthy

ID	P1Q1	P1Q2	P1Q3	P1Q4	P2Q1	P2Q2	P2Q3	P2Q4	P2Q5	P2Q6	P3Q1	P3Q2	P3Q3	P3Q4	P3Q5	P3Q6	P3Q7	P3Q8[SQ001]	P3Q8[SQ002]	P3Q8[SQ003]
173	18-29	Female	Student	Germany	4	5	4	4	3	4	Yes	Yes	Yes	Yes	4	2	4	Meat consumption	Not regional	Not seasonal
174	60-74	Female	Retired	Germany	4	4	4	2	3	4	Yes	No	Yes	Yes	2	1	3	Pigs	NA	NA
175	18-29	Female	Student	Germany	5	5	5	5	5	5	Yes	Yes	Yes	Yes	5	3	5	Meat consumption	Transport	Cooling
176	18-29	Male	Student	Germany	1	2	2	1	2	1	Yes	Yes	Yes	No	5	3	5	Transport	Necessary production of feed/watering	Energy consumption of machines during production
177	18-29	Female	Student	Germany	3	4	2	2	4	5	Yes	Yes	Yes	No	4	1	4	Trade	Production	Delivery
179	18-29	Female	Student	Germany	3	4	2	5	4	5	Yes	Yes	Yes	No	3	1	5	Transport routes	Seasonality (heating costs etc. for greenhouses and so on)	NA
180	18-29	Female	Student	Germany	4	5	4	5	5	5	Yes	Yes	Yes	Yes	5	3	5	Changed soil use	Transport	Water consumption
182	18-29	Female	Student	Germany	5	5	4	5	5	5	Yes	Yes	Yes	No	5	1	5	Meat	Coffee	Soy
184	30-44	Female	Employed	Germany	4	4	3	5	5	5	Yes	No	Yes	No	3	1	5	Industrial emissions	Industrial agriculture	Transport routes
185	18-29	Female	Student	Germany	4	4	3	5	4	5	Yes	Yes	Yes	No	4	1	4	Factory farming	Air transport	Non-seasonal groceries
186	30-44	Female	Self-Employed	Germany	5	5	5	5	5	5	Yes	Yes	Yes	Yes	5	4	5	Waste	Transport	Machines
188	18-29	Female	Student	Germany	4	3	3	4	3	4	Yes	Yes	Yes	No	3	2	4	Transport	Electricity	Feed
189	18-29	Female	Student	Germany	3	4	3	4	3	5	Yes	Yes	Yes	Yes	4	4	5	Packaging	Cultivation	Transport
190	18-29	Female	Student	Germany	4	4	2	5	5	5	Yes	Yes	Yes	Yes	3	2	4	Livestock farming	Transport	NA
194	18-29	Female	Student	Germany	5	4	4	5	3	5	Yes	Yes	Yes	Yes	4	5	5	Transport	Marketing	Fertilizer
197	18-29	Male	Student	Germany	4	2	4	2	3	5	Yes	Yes	Yes	No	4	1	5	Transport	Meat	Storage
198	18-29	Female	Student	Germany	5	5	4	5	5	5	Yes	Yes	Yes	No	4	1	5	Factory farming	Monocultures for feed for mass livestock	Non-seasonal products
199	18-29	Female	Student	Germany	4	3	4	5	5	5	Yes	Yes	Yes	Yes	4	1	5	Meat production	Coffee production	Imported production of goods
201	18-29	Male	Student	Germany	4	3	5	4	5	5	Yes	Yes	Yes	No	5	1	5	Factory farming	Rainforest deforestation	NA
203	18-29	Female	Student	Germany	3	3	1	1	2	3	Yes	No	Yes	No	4	1	4	Transport	Production	Packaging
204	18-29	Female	Student	Germany	4	4	NA	3	4	4	Yes	Yes	Yes	Yes	4	5	4	Meat industry	Packaging	Industrial agriculture
205	60-74	Female	Employed	Germany	3	3	3	3	4	5	Yes	No	Yes	Yes	4	3	4	Fertilizer	Pesticides	Agriculture
206	60-74	Female	Retired	Germany	4	3	5	3	4	5	Yes	Yes	Yes	Yes	4	4	4	Livestock	Transport of livestock and produce	Wasted produce
207	45-59	Female	Employed	UK	4	2	3	4	4	5	Yes	No	Yes	No	3	1	4	Intensity	Poverty	Greed
208	60-74	Female	Employed	UK	4	4	5	3	4	5	Yes	No	Yes	Yes	4	3	5	Greed	Convenience	Travel
209	45-59	Female	Employed	UK	3	1	4	1	3	4	No	No	Yes	No	2	1	2	Location	Delivery	Packaging
210	60-74	Female	Employed	Scotland	3	1	2	1	3	4	Yes	No	Yes	No	3	1	4	Airfreight	Packaging	Waste
211	45-59	Female	Employed	UK	4	3	3	1	4	3	Yes	No	No	No	2	1	4	Plastic	Fuel	Wastage
212	45-59	Female	Employed	Uk	3	2	2	1	3	4	No	No	Yes	No	2	1	4	Packaging	Logistics	NA

ID	P4Q1	P4Q2	P4Q3	P4Q4	P4Q5	P5Q1	P5Q2	P5Q3	P5Q4	P5Q5	P5Q6	P6Q1	P6Q2	P6Q3[SQ001]	P6Q3[SQ002]	P6Q3[SQ003]
173	4	5	4	5	3	5	2	2	4	3	4	5	4	Fair price	Good quality	Comprehensibility of CO2 calculation
174	4	4	5	2	4	4	2	4	4	4	4	3	3	Quality	Appealing	Price
175	3	5	4	4	4	4	2	4	5	3	4	5	5	NA	NA	NA
176	5	2	3	4	2	5	2	3	5	3	5	5	5	Easy comparison via app	Known brand	Explanation of composition on the back/external source (website/app)
177	5	5	3	2	2	4	2	2	5	5	4	4	4	Price	Origin of product	Quality
179	5	4	5	2	1	5	1	3	5	5	5	5	4	Colour (Appealing, e.g. green good -> morals adressed)	NA	NA
180	4	4	2	4	3	4	2	4	5	4	4	5	5	Lower CO2 footprint	Not a lot of packaging	Price
182	5	3	3	5	5	5	5	2	4	4	1	5	5	Regionality	Transparency	Organic/demeter certified
184	4	5	3	3	2	5	2	5	5	4	5	5	5	Lower price	More healthy one	Tasting better one
185	4	3	5	2	3	4	2	3	4	4	5	4	4	NA	NA	NA
186	5	5	5	1	5	5	1	5	5	5	5	5	5	Lower CO2 footprint	Regionality	Price
188	5	5	4	5	5	5	2	4	4	3	4	4	4	Climate change	Pressure of society	Transparency
189	5	5	4	2	3	5	2	5	5	2	3	4	4	NA	NA	NA
190	5	5	4	5	3	5	2	2	4	4	5	5	5	Protection of climate	The feeling to do something positive	Quality
194	2	4	4	5	2	4	4	1	5	2	5	4	4	Low footprint and organic	Low footprint and local	Low footprint and no packaging
197	4	5	5	2	3	5	4	4	4	5	4	5	2	Same price category	Same quality	NA
198	5	5	5	2	3	5	5	5	5	3	5	5	5	Simple design, I don't want to search for numbers	Redirection to more information (e.g. QR code)	NA
199	5	4	4	3	3	5	2	4	3	3	5	5	4	Seasonality	Visually appealing	Information on production conditions
201	5	5	5	1	1	5	1	5	5	5	5	5	5	Environment	NA	NA
203	3	5	4	1	2	4	1	2	5	3	4	4	4	No quality difference	Not too expensive	NA
204	5	4	3	3	2	4	2	4	4	2	4	4	3	Good feeling	Reduction of CO2 footprint	Relevance of the product (for my plans)
205	4	4	4	2	2	5	1	4	5	4	4	4	4	Environmental friendly - no pesticides	No plastic packing	Local produce - support Farmers
206	4	3	4	2	3	4	3	4	4	3	4	4	4	Information on its carbon footprint	Presentation - no plastics	Visual quality of product
207	5	4	5	NA	2	5	2	5	3	5	5	5	5	Country of origin	Health benefits	Low sugar
208	5	4	4	4	5	4	3	5	5	2	5	5	4	Provenance	Country of origin	Seasonality
209	4	4	4	1	1	5	1	1	5	4	3	4	4	Quality	Price	Variety
210	4	2	2	4	5	1	1	1	4	5	5	3	2	Price	Local	Packaging
211	5	5	5	4	1	2	1	4	4	1	3	4	3	Locally sourced product where possible	Smaller pack size	Information on label
212	4	4	4	3	4	4	3	2	3	2	1	3	3	NA	NA	NA

Declaration of Originality

I declare herewith, that this above-mentioned work (essay, project, thesis etc.) is my own original work. Furthermore, I confirm that:

− this work has been composed by me without assistance;

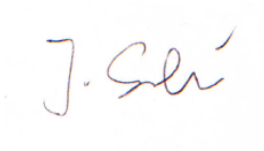
− I have clearly referenced in accordance with departmental requirements, in both the text and the bibliography or references, all sources (either from a printed source, internet or any other source) used in the work;

− all data and findings in the work have not been falsified or embellished;

− this work has not been previously, or concurrently, used either for other courses or within other exam processes as an exam work;

− this work has not been published.

I appreciate that any false claim in respect of this work will result in disciplinary action in accordance with university or departmental regulations. I confirm that I understand that my work may be electronically checked for plagiarism by the use of plagiarism detection software and stored on a third party's server for eventual future comparison.

Signature  Date 16th September 2020