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INTERPRETATIONS OF SUSTAINABILITY AND ITS IMPORTANCE IN THE CONTEXT OF TECHNOLOGY

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ABSTRACT

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Language is a cognitive process that enables the assignment and realization of meanings for words and concepts. Thus, people use language to make sense of phenomena in the world around them. Emergent global challenges have brought the concept of sustainability into discourse in various contexts. Previous studies investigating how people understand the concept have found out that sustainability is mainly made sense through the environmental dimension. However, sustainability can be considered a multidimensional entity with an ultimate aim of achieving a comprehensive and continuous state of wellbeing for both people and the environment globally enclosing at least the dimensions relating to environmental, economic, and social wellbeing. Sustainability is also a burgeoning theme in the context of technology given that technology may provide significant solutions for it. Particularly, such approaches are investigated in the field of sustainable human-computer interaction. Therefore, this thesis aimed to extend the topic of investigating how sustainability is understood to the context of technology. This was coupled with an additional aim of observing whether sustainability is perceived as important for technology further reflecting it with the participants' sustainability consciousness. The investigation was carried out as a literature review followed by an empirical study which was implemented using an online survey. The answers to the online questionnaire were collected in October 2020 and analysed statistically and via content analysis. The results indicated that within the context of technology sustainability was on average understood as comprising of environmental, developmental, and social dimensions leaving dimensions of confidence, temporal, economic, and compromise to the periphery. Principally, sustainability was associated with recycling, electric cars, and matters relating to energy in this context. Sustainability was considered on average important for technology further correlating positively with sustainability consciousness. Important sustainability attributes for technology were further identified. The results provide insight into how sustainability is understood in the context of technology design. They may also be of use for further research or practice relating to endeavours involved with sustainability and technology.

Keywords: sustainability, sustainable development, language, cognitive linguistics, mental representation, human-computer interaction

TIIVISTELMÄ

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Kieli on kognitiivinen prosessi, joka mahdollistaa sanojen ja käsitteiden merkitysten määräämisen ja tiedostamisen. Näin ollen ihmiset käyttävät kieltä ymmärtääkseen ympäröivän maailman ilmiöitä. Kasvavat globaalit haasteet ovat nostaneet kestävän kehityksen käsitteen keskusteluun eri yhteyksissä. Aiemmat tutkimukset, jotka ovat selvittäneet miten ihmiset ymmärtävät kestävän kehityksen käsitteen ovat saaneet selville, että kestävä kehitys käsitetään pääasiassa ympäristöulottuvuuden kautta. Tästä huolimatta kestävän kehityksen voidaan ajatella olevan moniulotteinen kokonaisuus, jonka perimmäinen tavoite on saavuttaa globaali kokonaisvaltainen ja jatkuva hyvinvoinnin tila niin ihmisille kuin ympäristölle, ja johon sisältyvät ainakin ulottuvuudet, jotka liittyvät ympäristön, talouden, ja sosiaaliseen hyvinvointiin. Kestävä kehitys on myös kasvava teema teknologian yhteydessä ottaen huomioon, että teknologia saattaa tarjota merkittäviä ratkaisuja sen saavuttamiseksi. Näitä kestävään kehitykseen liittyviä lähestymistapoja tutkitaan kestävän ihmisen ja tietokoneen välisen vuorovaikutuksen tutkimuskentällä. Näin ollen tämä tutkielma pyrki laajentamaan kestävän kehityksen ymmärtämisen tutkimisen aihetta tuomalla sen teknologian kontekstiin. Lisäksi tämä tutkielma pyrki tarkastelemaan mielletäänkö kestävä kehitys tärkeäksi teknologialle verraten näitä käsityksiä osallistujien tietoisuuteen kestävästä kehityksestä. Tämä tarkastelu toteutettiin kirjallisuuskatsauksena, jota seurasi empiirinen tutkimus, jonka toteutukseen käytettiin verkkokyselyä. Vastaukset verkkokyselyyn kerättiin lokakuussa 2020 ja ne analysoitiin tilastollisesti sekä käyttäen sisällönanalyysiä. Saadut tulokset osoittivat, että teknologian kontekstissa kestävän kehityksen ymmärrettiin keskimäärin muodostuvan ympäristö-, kehitys- ja sosiaalisesta ulottuvuudesta jättäen muut tarkastellut luottamukseen, aikaan, talouteen ja kompromissiin liittyvät ulottuvuudet taka-alalle. Tässä kontekstissa kestävä kehitys yhdistettiin eritoten kierrätykseen, sähköautoihin ja energiaan liittyviin asioihin. Kestävää kehitystä pidettiin keskimäärin tärkeänä teknologialle, mikä edelleen korreloi positiivisesti kestävän kehityksen tietoisuuden kanssa. Lisäksi teknologialle tärkeitä kestävään kehitykseen liittyviä ominaisuuksia tunnistettiin. Tulokset tarjoavat käsityksen siitä, miten kestävä kehitys ymmärretään teknologian suunnittelun yhteydessä. Tämän lisäksi niistä voi olla hyötyä kestävän kehityksen ja teknologiaan liittyvissä pyrkimyksissä niin tutkimuksen kuin käytännön alueilla.

Asiasanat: kestävyys, kestävä kehitys, kieli, kognitiivinen lingvistiikka, mentaalinen representaatio, ihmisen ja tietokoneen välinen vuorovaikutus

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1 INTRODUCTION

People encounter vast amounts of different kinds of information every day. This information can enforce or question their pre-existing understanding of a specific topic, or it can be completely new. Nonetheless, it is typical that people construct their understanding of a particular topic based on information that is attained via different means in varying quantities throughout their lifespan, a theory also known as constructivism. Constructivism poses that people acquire knowledge through a process of reflection and active construction in the mind where reality is seen determined by one's experiences (Fox, 2001). This process – from a social constructivism point of view – is affected by social interaction and culture (Vygotsky, 1978). Given this premise, not everyone encounters the same information at the same time in a similar manner leading to numerous variant ways of making sense of a topic. Language as a cognitive process provides an important medium through which information is produced and obtained, thus offering a way to investigate understanding. That is, via language it is not only possible to communicate real and imagined things and processes to others but also to think of them and other intangible ideas as well (Sternberg & Sternberg, 2012). Some even argue that language *is* thought (e.g., Fodor, 2008). People, however, are not homogenous in the way they understand phenomena despite the existence of definitions and concepts aimed to guide them in a determined and desired direction. Put differently, the mental representations constructed by language may vary among individuals. Sometimes, however, a phenomenon may benefit from a mutual and explicit understanding of its concepts in addition to those freely constructed in human minds. In such cases, concepts may seek to unite people behind a cause or an action, giving a tangible name to a tacit idea or experience, working as building blocks for understanding, and thus having wider implications for social reality. Indeed, language is a highly influential persuasion device that can be used to induce people to take certain action (David, 2014). For a while now the concept of sustainability has aimed to connect people behind a shared cause of achieving overarching global well-being for both the people and the environment on this planet. This can be seen in practice, for instance, in the case of sustainable tourism where sustaina-

bility rhetoric plays an important role (e.g., Cunningham et al., 2012; Weiler et al., 2011).

Sustainability poses the basic premise that the resources of Earth cannot be exploited indefinitely (Portney, 2015). It is often described as an entity consisting of dimensions that vary in their number and importance depending on the context and the person defining the concept. That is, sustainability seems to mean different things to different people (White, 2013). Commonly, it is described as a multifaceted universal concept that integrates environmental, economic, and social dimensions (Rout et al., 2020). In many cases, the concept of sustainability takes form based on the frameworks passed on by the United Nations (e.g., WCED, 1987; UN General Assembly, 2015) where sustainability is mainly about the actions leading to a secured and balanced life quality for both the current and future generations. As such, it is about long-term dynamic processes (Portney, 2015). The influential position of these international policies has naturally affected how governments, corporations, and media have internalized the concept of sustainability further extending the effect to societies and people populating them. However, basing the sustainability concept on political grammar that the aforementioned institutions promote can be considered problematic. This is due to the fact that it restricts what is seen, thought, and said, constructing and simultaneously barring social reality. In other words, as Hammond (2020) argues, political grammar often blocks the transformability that is the essence of sustainability. That is, sustainability is more than sets of defined outcome indicators: it is "a process of continuous reflexivity and transformation" (Hammond, 2020, p. 188). The reflexivity and transformation, or the lack of the two possibly caused by the predominant political grammar, can be found from the socially negotiated meanings assigned to sustainability. For instance, even though the dimensionality of sustainability is evident for some, consumers realize the concept mainly through environmental aspects (e.g., Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012). The reason for this may partly be due to the media coverage on global warming and biodiversity loss; ecological perspective on sustainability provides observable and measurable and thus reportable data, whereas social perspective, for instance, may pose a more complex investigation. Thus, research and policy reports that are used as a reference may result in a skewed information flow influencing how the meaning of sustainability is individually and collectively constructed (Hanss & Böhm, 2012). In other words, the political climate can be seen to have a great influence in altering the prevailing culture around sustainability on a global and local level. Consequently, the prevailing culture further shapes how people make sense of and position themselves in relation to sustainability.

Currently, sustainability is shown to be a significant attribute in purchasing situations affecting the selection process of brands and products (Haller et al., 2020). Thus, it is only natural that sustainability has found its way into the technology industry as well. Indeed, underlining the prevalent culture, sustainability is present in the strategies of major technology companies especially in terms of actions relating to the environment and carbon neutrality (e.g., Apple, 2020; Pichai, 2020). In other words, sustainability has become one of the key values of customers (Haller et al., 2020) and therefore, a key topic of discussion

also around existing and new technologies. It could be said, that in an ideal case, the technology people use reflects their values. However, those in charge of designing new technologies are facing obstacles in positioning themselves towards the challenge of contributing to a more sustainable future, not least when it comes to the actual concept of sustainability (Knowles et al., 2018). As a consequence, the transition of the value of sustainability into the designs may be challenging. Thus, in this context, the language of sustainability instead of clarifying the way towards positive change can be considered to have hindering effects to the implementation of actions needed for it.

Inspired by the research on consumer understandings of the sustainability concept, the primary objective of this thesis is to empirically investigate how sustainability is understood in the specific context of technology. Specifically, it aims to observe the saliency of predetermined sustainability dimensions outside and within the context of technology. It finds it also meaningful to observe whether sustainability is perceived as important for technology. In the scope of this thesis, technology is defined as an artefact that facilitates people to pursue their action goals (Saariluoma et al., 2016). Accordingly, the context of technology stands for any occurrence where technology is experienced to be present. Within the thesis, discourse about sustainability in the context of technology is especially observed from the field of human-computer interaction. Investigating sustainability in this particular context is seen as important and topical as the efforts to achieve sustainability are increasingly connected to technological innovations that most likely will affect the everyday lives of peoples. Furthermore, observing how people relate sustainability with technology may provide valuable insight from a novel perspective for research and practice dealing with sustainability in relation to technology. To the knowledge of this thesis, there exist no studies that would have investigated the understanding of the sustainability concept in this particular context. Therefore, the current thesis undertakes the research problem laid out in this paragraph through the following research questions:

- How is sustainability understood in the context of technology?
- Is sustainability perceived as important for technology?

In order to approach the study objective, a review of relevant academic literature was implemented. Specifically, the literature was obtained using the search engines Google Scholar, Scopus, and JYKDOK with the different combinations of the following keywords: *"Sustainability"*, *"Sustainable Development"*, *"Mental Representation"*, *"Meaning"*, *"Understanding"*, *"Language"*, *"Thought"*, *"Technology"*, *"Human-Computer Interaction"*, and *"HCI"*. Following the review, a survey questionnaire was implemented in October 2020. The online survey (N=235) comprising of a free association element in addition to structured and open-ended questions aimed to measure how sustainability is understood in the context of technology and its perceived importance to technology. The data was obtained via the email lists of University of Jyväskylä and personal email.

Before moving to the structure of the current thesis it is important to look at the terminology used in it. Specifically, it is significant to note that while the

term "sustainability" is preferred throughout the current thesis whenever possible, in the implemented study the term "sustainable development" was used. This was due to the translation challenge that occurs when the given terms are translated into Finnish. The term *sustainability*[1] was considered too ambiguous in the Finnish language for the objective of this thesis resulting in the use of the term *sustainable development*[2], which is commonly used in media and national publications in Finland. Hence, given that sustainable development is used in the implemented questionnaire, in the fifth chapter where the results are discussed, the formulation of sustainable development is used instead of sustainability. That being said, despite the possible semantic and definitional differences (e.g., Fergus & Rowney, 2005), within the scope of this thesis, the terms should be considered to be of the same meaning. Furthermore, acknowledging the complexity of the concept, the focus is on sustainability as generally presented in the Global North.

This thesis is organized into seven chapters of which the second and third elaborate the theoretical foundation of the study. Accordingly, the second chapter introduces the process of meaning-making. Specifically, it observes language in terms of its relationship to thought and meaning and reviews the functions of language such as how concepts are represented in the mind. That is, it reviews language's role in negotiating and assigning meaning and explains the cognitive processes of connecting thoughts and ideas to particular mental representations. Following this, the third chapter views the concept of sustainability and frames the dimensions attributed to it in general discussion as well as in connection to technology in the discourse in sustainable human-computer interaction. After the theoretical basis, chapters four and five illuminate the empirical part of the thesis. That is, chapter four introduces the methodology used to implement the study, whereas chapter five presents the obtained results. Chapter six provides a discussion of the findings. Finally, the conclusion in chapter seven summarizes the thesis and gathers the results together alongside limitations and suggestions for future topics of study.

[1] In Finnish *"kestävyys"*
[2] In Finnish *"kestävä kehitys"*

2 LANGUAGE AND ITS FUNCTION

As outlined in the previous chapter, the current thesis aims to observe how people make sense of the concept of sustainability. In order to do that, this chapter looks at understanding from the perspective of language. More specifically, the first subchapter starts with an overlook of language and introduces some established theories relating to the relationship of language and thought in addition to reviewing some proposals on how meaning is constructed. Following this, the second chapter looks into the symbolic and interactive function of language and into the process of how language is represented in the mind. This theoretical background relating to the role of language in understanding presented in this chapter lays ground for the later investigation of how the concept of sustainability is understood.

2.1 Language, Thought and Meaning

An influential linguist Chomsky (1959) sees that the way people come to acquire language is innate. In other words, the author sees that language and grammar are something that human brains are biologically programmed to learn and thus independent of other processes of the brain. According to Chomsky, this inherent preset makes the unconscious knowledge of language universal to all humans regardless of the language they speak as it is genetically determined and independent of sensory experiences. That is, people around the world are seen to share a genetic competence to language that does not vary between or within languages and environments. The author calls this innate language-knowledge system Universal Grammar (Chomsky, 1986). However, much of this work has later been criticized because of its rigidity. For instance, all cognition, or mental processes and actions relating to knowledge acquisition and understanding, have been long recognized to be embodied (Watson-Gegeo, 2004). By embodied, it is meant that cognition is shaped not only by the brain but by the aspects of the physical body as well (Wilson & Foglia, 2017). Specifically, language is considered explicit knowledge or knowledge with some kind

of representational form, whereas a great deal of the embodied knowledge of people is implicit, such as the sense of identity, the embodiment of social roles, getting dressed and undressed, and the sense of pain in traumatic memory (Shusterman, 2011), for instance. Furthermore, continuing with the criticism of Chomsky's language universals, the claim of biologically based universal language among humans is not seen as evolutionarily viable (Christiansen & Chater, 2008) not to mention the social aspects of language that are largely ignored in Chomsky's work (Geeraerts, 2006). Therefore, understanding language as a mere function of a computational brain can be seen reductive as language indeed is much more than that.

Language gives people instruments to navigate and operate in the world as it facilitates communicating information, achieving goals, and sharing ideas. With the help of language tacit pieces of information containing meaning can be communicated to others via various means such as speaking, writing, and gesturing. Furthermore, designers can be seen to use language in constructing design experiences as these are based on the formal and embodied interaction between the designer and the user of the particular design (Rousi, 2013; Saariluoma & Rousi, 2015). Therefore, language can be seen as a socially shared semiotic tool that allows the making and exchange of meaning in explicit and implicit social interaction situations (Holtgraves & Kashima, 2008). In other words, language allows meaning to be actively and collaboratively constructed in varied interactive instances (Burkette & Kretzschmar Jr., 2018). Importantly, these instances are affected by the various factors involved in them. For example, one can easily recognize that the actors, contexts, and purposes of their interaction instances vary. Similarly, then, it may be possible to recognize how the language in them change and meanings of words take different shape. This is further explored in the section relating to language and meaning.

Remaining to observe language more generally, it can also be said that language is a powerful tool that can affect reality. That is, the experienced reality can be seen dynamically taking shape via the means of language as intangible thoughts and ideas are compressed into words and concepts. As Burkette & Kretzschmar Jr (2018) argue, the reality people live in is not predetermined and fixed but one that is created through categories and relationships that become evident through the medium of language. In particular, language provides tools such as names and labels that help to organize and arrange raw sensory input such as views, sounds and smells obtained from the external world, further structuring the perceptions of language users relating to the so-called world out there (Burkette & Kretzschmar Jr., 2018). Differently put, language converts the experiences of people into communicable form (Holtgraves & Kashima, 2008) allowing that the experiences can be shared with others. Therefore, in addition to working as a decoding machine for sensory experiences, language can be seen as a socially constructed interactive function that makes simultaneously complex and coordinated social behaviour among people possible (Friedenberg & Silverman, 2016), while attending to the construction and reshaping of the everyday reality. Next, the relationship between language and thought is explored more in detail through some established theories.

Language and thought

Does language affect thought or thought language? How are abstract concepts understood? People have been interested in the relationship between language and thought for a long time which has resulted in different viewpoints on the matter. Here, three established theories relating to this relationship are briefly reviewed.

First, the linguistic relativity hypothesis, also known as the Sapir-Whorf hypothesis named after Sapir (1921) and Whorf (1956), the often-assigned originators of the proposal, postulates that the particular language being spoken by an individual influences the way they think about reality (Lucy, 1997). In other words, the proposal suggests that people speaking a particular language experience reality differently than people speaking another language. This would mean, for example, that those speaking Finnish have experiences of reality that differ from those speaking English. Specifically, linguistic relativity is made of three main ideas: languages can have significant differences in the meanings of their words and their constructions relating to rules of language; the semantics, or meanings, of a language can affect the way the world is perceived and conceptualized by its speakers to the extreme where it is considered to affect thought, also known as linguistic determinism; and, speakers of different languages think differently (Wolff & Holmes, 2011). Thus, within this hypothesis language can be considered to have priority over thought. While the original proposal lacks a solid theoretical and empirical validity (e.g., Lucy, 1997), it has served as an inspiration to the study of the relationship between language and thought (Wolff & Holmes, 2011). For instance, Kim and Filimonau (2017) recently found that language may shape the pro-environmental attitudes of tourists. Accordingly, Wolff & Holmes (2011) argue that language can have a profound effect on thought as it may put in place representational systems that make certain kinds of thinking possible.

Moving on to the second proposal being reviewed, Fodor (1975), on the other hand, sees that thought has a priority over language. Here, an important concept is a mental representation. While a representation can be considered to be an object with semantic properties, a mental representation involved in several mental states and processes refers to a mental object with semantic properties (Pitt, 2020). In other words, representation stands for something. For instance, a drawn picture of a sunflower attempted to look like one is a representation of a sunflower in the world. In other words, the drawing (sign) can be seen to function as a signifier for what is being signified, that is a sunflower (object), further resulting to understanding of that sign/object relation (Peirce, 1998). The sunflower can be realized as a mental representation as well: it is possible to "see" and "smell" the flower and "feel" its texture within one's mind given that one has encountered a sunflower in the real world. That is, mental representation holds connections to explicit knowledge and properties (Rousi, 2013). And even if one does not have this experience, mental representation allows the representation of an imagined sunflower, thus enabling access to representations of both non-experienced and non-existing objects and ideas (Sternberg & Sternberg, 2012). Shifting the focus back to Fodor (1975), the au-

thor proposes that mental representation has a linguistic form, that is, thought and thinking happen in an innate mental language also known as *Mentalese*. This proposal is also known as the Language of Thought Hypothesis. Specifically, the hypothesis postulates that when people think of something, a representational system in their brains produces internal mental language that is formal in that it consists of rules (syntax) and meaning (semantics). A way to think about this mental language is to think of it as sentences not accessible to the thinker consisting of words that are meaningful in themselves but that create a meaningful whole also when correctly combined with each other or used in other sentences (Rescorla, 2019). In other words, these entities carry meaning alone but can also be connected and reorganized within the rules to produce further meaning. Thus, according to Fodor (1975), the representational system of mental language has a similar structure to external language given the compositional and systematic character of syntactic and semantic rules, and this system is, for instance, used to represent denotations to words, therefore making understanding words and language possible (Rescorla, 2019) further suggesting that thought affects language.

A third and a further way to look at the relationship of language and thought is through metaphors. Introduced by Lakoff and Johnson (1980), conceptual metaphor theory argues that people use metaphors to comprehend abstract concepts and perform abstract reasoning. In other words, concepts such as love may be understood via metaphors. The process is mainly unconscious despite metaphors are widely used by people and they obtain flexibility to transfer meaning from a word to another (Burkette & Kretzschmar Jr., 2018). Conceptual metaphor thus relates to thinking and thought in being a mechanism for mental processes and actions; metaphorical expressions and language are merely surface manifestations of conceptual metaphor (Lakoff, 2006). Conceptual metaphors can be defined as "mental connections between two unrelated ideas in which the qualities of one concept are mapped onto another" (Burkette & Kretzschmar Jr., 2018, p. 140), however a particular metaphor does not have to be restricted to a single lexical item, but it may generalize over distinct expressions (Geeraerts, 2006). An example of conceptual metaphor provided by Lakoff and Johnson (1980) is LOVE IS A JOURNEY, where the concept of love is made sense with the help of the concept journey indicating that throughout love there may be obstacles, highs and lows, et cetera, similar to what may be experienced on an actual journey taken somewhere. In other words, interaction between different domains of experience is involved in metaphors (Geeraerts, 2006). Thousands of these mappings exist that vary in their universality from what seems universal to those that are culture-specific, and that are grounded in the body and everyday experiences and knowledge (Lakoff, 2006), thus they are embodied. Differently put, a conceptual metaphor can be seen as a culture-wide tendency to understand one fixed sort of phenomenon as and in terms of another fixed sort of thing (Hills, 2017) with the essential function of allowing people to grasp an abstract or unstructured subject matter in terms of a more concrete or structured one (Lakoff, 2006).

Looking at the three theories presented above, the main tenets can be summarized followingly. First, the relationship of language and thought can be

approached by understanding that language has an effect on thought that extends to experienced reality. Second, thought is organized as language consisting of rules and meanings affecting language. And, third, abstract subjects are made sense via the use of language in terms of metaphor, thus language is providing a medium that is applied in understanding abstract items. Therefore, it could be concluded that language and thought have a dynamic relationship that has implications extending from individual and collective minds all the way to reality. Next, the inspection is turned to language and meaning.

Language and meaning

Relating to the previous section, significant interest has been given to the relationship between language and meaning. How does meaning come to be? Several theorists have proposed their point of view to the matter, however, within the current thesis, three proposals looking at meaning from distinct viewpoints are next reviewed.

First, as elaborated by Raatikainen (2014), the philosopher Wittgenstein (1953) argues that language and meaning come to be in the non-linguistic and unconscious social practices and relations in which people participate throughout their lifespan. These practices as well as the language used in them vary, leaving people to participate in something Wittgenstein (1953) calls language games. In other words, the language people use is context-dependent, fluid, and free of strict predetermined rules (Raatikainen, 2014). Different social situations with their tacit customs result in different linguistic practices, therefore the function of language cannot be observed outside its context of use (Wittgenstein, 1953). People adapt language depending on context and while doing so participate in a particular language game with its own set of rules that are learned within the linguistic community playing the game (Mauws & Phillips, 1995). Words and expressions end up having different meanings depending on the language game that is being played because the concepts used in them change (Wittgenstein, 1953). For instance, it can be imagined that the language used within a particular friend group may differ from that used with family, at work, or when visiting a doctor's office just as particular concepts used in one social context may obtain different meanings when used in another. Thus, participation in a particular language game produces a particular reality (Mauws & Phillips, 1995). In this sense, Wittgenstein (1953) sees that language is always absorbed in practical action affecting social realities and therefore, to some extent, also thought (Raatikainen, 2014).

Turning to the second proposal, Putnam (1975) suggests that linguistic meaning is not strictly a mental entity or conceptual construct but extends to the external reality. As Ben-Menahem (n.d.) explains, meaning thus takes shape in the action of pointing to an entity when introducing or explaining a term. For instance, the meaning of sunflower comes to be as the particular flowers are encountered in the world. What the proposal thus suggests is that facts about the external environment constitute meaning. However, external environments vary. Therefore, even if it is possible for people to associate a word, such as sunflower, in exactly the same way through beliefs, mental images, or definition,

they may still ascribe different meanings to it because of the differing environments in which the word is used (Ben-Menahem, n.d.). This conception is known as semantic externalism. In addition to this proposal, Putnam (1975) suggests that when it comes to language, ordinary users of language do not need to have a detailed knowledge of it in terms of meaning as long as there exist experts in the speaker community who do. That is to say, not all people who successfully use the word sunflower need to have the knowledge to understand what a sunflower comprises, as long as some people who do know exists. This so-called division of linguistic labour highlights the context-dependence of linguistic practices in terms of speaker background and conversational context and therefore explains the existence of differing meanings that, for instance, the word sunflower may receive in different cultures at different times (Ben-Menahem, n.d.). In this sense, terms change over time in relation to their semantic content and they attain new definitions and beliefs. While these definitions and beliefs vary from the original, they can be seen equally valid as those given to the original terms. Thus, the different definitions and beliefs can be considered merely products of changing cultural conditions.

Finally, Lotman (2005) presents a further viewpoint to meaning and language by introducing the concept of semiosphere, that is, "the semiotic space, outside of which semiosis cannot exist" (p. 205). Differently put, a semiosphere signifies an abstract or concrete space with abstract or concrete borders possessing signs and symbols that are required for the representation of meaning in language. That is, language does not function or exist without this space where communicative processes and the creation of novel information are carried out (Lotman, 2005). Therefore, semiosphere can be understood as a collective intellect or consciousness in which communication and meaning generation happens (Semenenko, 2016). Given this, culture, for example, can be considered a semiosphere within which communication occurs and meaning is negotiated as it contains abstract borders within which interaction with reality happens and meaning takes place. In this sense, the concept of semiosphere as a collective mental sphere underlines that cognition as in the mental actions and processes of humans realized through thoughts, experiences, and senses, "develops and is effectuated through interaction with other individuals, material objects, and other phenomena of reality" (Semenenko, 2016, p. 499) and therefore is not merely an independent internal process. Indeed, cognition is understood to be distributed not only within but among individuals and thus socially constructed through collaboration (Watson-Gegeo, 2004). Accordingly, the process of meaningful social interaction in terms of construction and exchange of meaning can be observed as social cognition (Holtgraves & Kashima, 2008). Extending this thought further, language is a part of variety of social-cognitive processes and the nature of the language being used as well as the act of using it play important roles in these processes (Holtgraves & Kashima, 2008). Hence, all cognition is essentially social cognition as it is connected to the real or imagined presence of others (Holtgraves & Kashima, 2008). Thus, it can be considered that social interaction that is shaped by cultural and political processes constitutes the originating power of the processes and actions of the human mind

(Watson-Gegeo, 2004), something that can be seen supported in the proposition put forward by Lotman (2005) as well.

The reviewed proposals provide a peek into how the relationship between language and meaning is theorized. What seems common to all of the propositions is the acknowledgment of the significance of context; meaning is birthed in the interaction that takes place among people. In this sense, meaning can be considered fluid and, in particular, a social phenomenon. Indeed, Holtgraves and Kashima (2008) see that in the process of creating and exchanging meaning people using a particular language become connected to one another through the shared symbolic system they obtain. This collaborative language use further influences how meaning is represented by all the participants in an interaction situation (Holtgraves & Kashima, 2008), as these communicative contexts contain social, cultural, and political dimensions that affect the availability and knowingness of linguistic forms and their representation (Watson-Gegeo, 2004). Having to do with this, the functions and representation of language in the mind are reviewed next.

2.2 Function of Language

According to Evans and Green (2006), language can be seen as a meaning expressing system with a systematic structure and two key functions: the symbolic function and the interactive function. In this sense, language is made of symbolic assemblies, or conventional linguistic units, that connect signs and meanings, and that are further combined themselves to execute the symbolic and interactive functions. The authors emphasize that an important aspect of language is that what something means does not just merely exist in the world, but people actively agree on the meanings of the various signs or forms, hence making language a strictly social process. What follows is that essentially how different words are understood when they are read or heard or seen signed is a result of the agreement for the meaning for this particular set of signs. Thus, symbolic assemblies are pieces of language that are recognized by the speaker while their meanings and usage are generally agreed upon within the language community (Evans & Green, 2006). Taking a closer look into the function of language especially in terms of its representation, this subchapter looks first into the symbolic function and then into the interactive function of language.

Clarified by Evans and Green (2006), the symbolic function of language refers to encoding and externalizing thoughts by representing and symbolizing concepts. As the name suggests, this happens through the use of symbols, bits of language that consist of forms and meanings. A form is something that is paired with meaning and it can be spoken, written, or signed. For example, a word that is said out loud, written, or signed is a form (Evans & Green, 2006). What follows is that specific words end up having conceptual and phonetic associations that come to be through habit, recognition, and repetition, and the closest or most typically used of these associations emerge meaning (Burkette & Kretzschmar Jr., 2018). Meaning can here be defined as the accustomed for-

mation of conception associated with a symbol linked to a specific mental representation called a concept (Evans & Green, 2006). Concepts, on the other hand, can be defined as "flexible, experience-dependent modality-specific representations" (p. 817) that are distributed through sensory and motor systems (Kiefer & Pulvermüller, 2012). In other words, as Evans & Green (2006) continue, concepts derive from perceptions executed by the brain. What that means, as the authors explain, is that perceptual information obtained from the external world, such as what is seen or heard, is formulated into a representation or a mental image available for consciousness which then gives rise to the concept in question. When language is used to utter a particular form, it is connected to a conventional meaning and thus to a concept instead of the physical object in the world directly (Evans & Green, 2006). For instance, when language is used to utter the form sunflower, it is connected to the accustomed meaning that is agreed upon regarding sunflower. In other words, that a consensual understanding of the concept of sunflower states that sunflowers are big yellow flowers which, on the other hand, may at times be in contrast with what is actually experienced in the world. In particular, utterances are symbolic units that aim to signal local and contextually relevant communication intentions in distinct language usage-events (Evans, 2012). Meanwhile conceptualization is believed to be the source of constructing meaning: it is imaginative while being grounded in physical reality. This makes the process both individual and social (Burkette & Kretzschmar Jr., 2018). Accordingly, an unlimited number of conceptualizations exists that are merely prompted by words (Evans & Green, 2006). This process and the levels of representation are elaborated in Figure 1. However, as Evans and Green (2006) explain, language does not encode thought in its complex entirety but rather gives basic instructions to the conceptual system to access or create rich and elaborate ideas. This is further visible in that words have a range of interpretations, where the words with meanings themselves are only partially responsible for the conceptualization they give rise to because of these meanings (Evans & Green, 2006). This can be seen to further illustrate the differences between the semiotic models of the linguistic scholars Peirce and de Saussure, where the former argues that there exists always a real-world constituent of each sign, whereas the latter poses that signs exist only in the mind (Yakin & Totu, 2014).

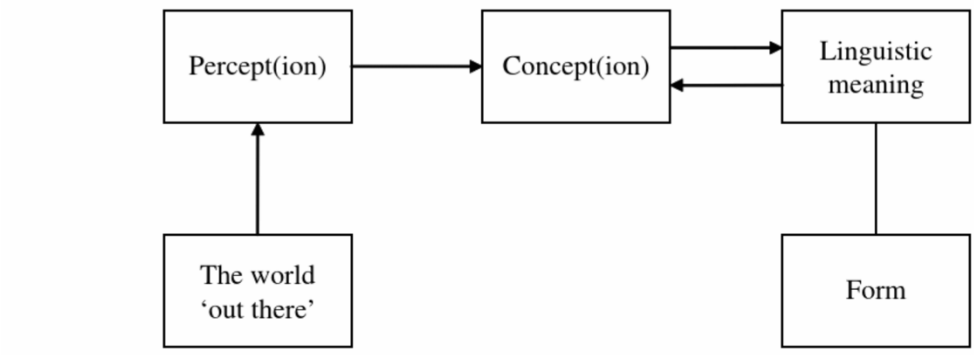

FIGURE 1 Levels of representation (Evans & Green, 2006, p. 7)

Moving on to the other function of language, Evans and Green (2006) elaborate that just as importantly as language pairs forms and meanings it also makes them recognizable and accessible to others in the speaker community. That is, a sign, such as a word, is meaningless in isolation – a mental content attributed to it by someone in a specific situation is needed for it to have meaning (Saariluoma & Rousi, 2015). Accordingly, it can be argued that to recognize and use language, corresponding mental contents need to be activated in the minds of individuals (Saariluoma & Rousi, 2015). Thus, the interactive function of language plays an important part in everyday social encounters. In particular, this interaction becomes possible through the processes of constructing and transmitting conceptualizations and the processes of decoding and interpreting them, for example, by speaking and hearing (Evans & Green, 2006). Language users, thus, need to be active participants in the process of achieving complete and mutual understanding of the created or exchanged meaning as this is not guaranteed to happen through the mere message (Holtgraves & Kashima, 2008). Evans and Green (2006) move on to explain that the messages that are chosen to communicate have the ability to perform various interactive and social functions. For instance, as the authors explain, with speech acts such as commands and socially recognized statements language can be used to change the way the world is, or to make things happen. Thus, language can be used to assign and confirm roles and power. It can also be used to communicate and exchange wishes and desires further signalling fundamental aspects of who one is or wants to be, and what the relationship between the interlocutors is depending on the style of language that is used to express these. Put differently, language as a speech act has the power to alter aspects of the perceived reality (Evans & Green, 2006).

Furthermore, as Evans and Green (2006) continue, language is expressive in that it allows the expression of thoughts and feelings about the world and makes it possible to derive meaning in social settings, for instance, due to normative patterns of linguistic behaviour and social stereotypes. It further has to do with how people affect one another and make them feel by the choice of words, thus it may provide information about an emotional response or affect. Additionally, how people present themselves in public happens through language as the language that is chosen to use conveys information about attitudes concerning others, people themselves, and the situations people find themselves in. Language invokes frames of experience that help to make sense of the situation as they call up and fill in background knowledge which guides interactions in terms of how to respond to what follows and what the expectations should be. Thus, language does not merely encode distinct meanings but serves an interactive function further facilitating and enriching communication given that the meanings and the forms used to symbolize them constitute part of shared knowledge in a given speech community (Evans & Green, 2006), highlighting the significance of language for social cognition.

Thus, it can be said that that the nature of human communication is highly complex and expressive and varies among inter-groups (Levinson & Holler, 2014). It receives information from multiple modalities (e.g., speech, text, gestures) and perceptual senses (e.g., olfactory, haptic, visual, and auditory) (Hol-

ler & Levinson, 2019). In other words, human communication is a "system of systems" (Levinson & Holler, 2014, p. 1), where language use is the combination of context-dependent distinct modalities that come to play and work together to understand and produce meaning. Therefore, language is not static but a dynamic process that comes to be through interaction with other people and is guided by various signals deriving from these multiple channels of expression that are relevant in a particular communication instance. Consequently, mental representation can be seen as a social activity enabled through language and its usage.

3 NOTIONS OF SUSTAINABILITY

After the previous overlook into the relationship language has with thought and meaning, and into the function of language, this chapter introduces the reader to the concept of sustainability and the dimensions it is seen to enclose outside and within the context of technology. The first subchapter presents the concept in question and outlines relevant dimensions that are being used to make sense of it. Following this, the second subchapter moves the discussion to the context of technology, specifically, it observes the meanings assigned to sustainability in the discourse found from the field of sustainable human-computer interaction. Displaying how sustainability is made sense from these standpoints contributes to the theoretical background with the previous chapter further outlining the research that is undertaken in the final parts of this thesis.

3.1 Sustainability

An often-quoted definition by the World Commission on Environment and Development, also known as the Brundtland Report, defines sustainability as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs" (WCED, 1987, p. 43). Today, the online dictionary Merriam-Webster (n.d.) defines the term via the adjective "sustainable", standing for "capable of being sustained". Elaborated further, sustainability is stated to refer to both a method of resource utilization in a manner that does not deplete or permanently damage the resource and to a lifestyle where sustainable methods are used (Merriam-Webster, n.d.). Given that sustainability is a concept realized by humans living on the planet Earth, it can be considered that the focus of it indeed rests in the condition of Earth's biophysical environment. This means that sustainability is concerned with the physical environment and all those living within it, as well as with the means that affect this condition one way or another (Portney, 2015). Fundamentally, sustainability seeks to achieve a stable state among the domains comprising and operating in this environment (Portney, 2015) with a primary focus on the inter-

related, holistic, and long-term wellbeing of humans and nature (Moldan et al., 2012).

Sustainability is commonly realized through the use of dimensions representing distinct entities that vary depending on the context. Often however, sustainability is seen to require the integration of environmental management, economic growth, and social development in a multi-stakeholder manner (Rout et al., 2020). Indeed, the dimensions of environment, economy, and society are frequently used in a normative manner to construe a tripartite description of sustainability. This can be illustrated in a form of three intersecting circles, nested concentric circles, or pillars, respectively (Purvis et al., 2019). Trade-offs between the dimensions are not allowed; in order to achieve sustainability, achievements in all of the dimensions need to be accomplished (Portney, 2015). These common representations are illustrated in Figure 2. The formation of this ternary division is attributed to a number of United Nations' reports on sustainability, such as the Brundtland Report, that brought the concept to wider international attention and onto important strategic documents (Moldan et al., 2012). However, this exists without a solid theoretical foundation rendering the origin of the division of these components somewhat problematic (Purvis et al., 2019). Currently, while comfortably resting on the three dimensions of sustainability, the UN's Sustainable Development Goals (UN General Assembly, 2015) provide a more diverse set of guidelines for policymakers globally. Nevertheless, at the end of the day, the ternary view can be seen to enjoy a normative position as the "'common sense' understanding of sustainability" (Purvis et al., 2019, p. 691).

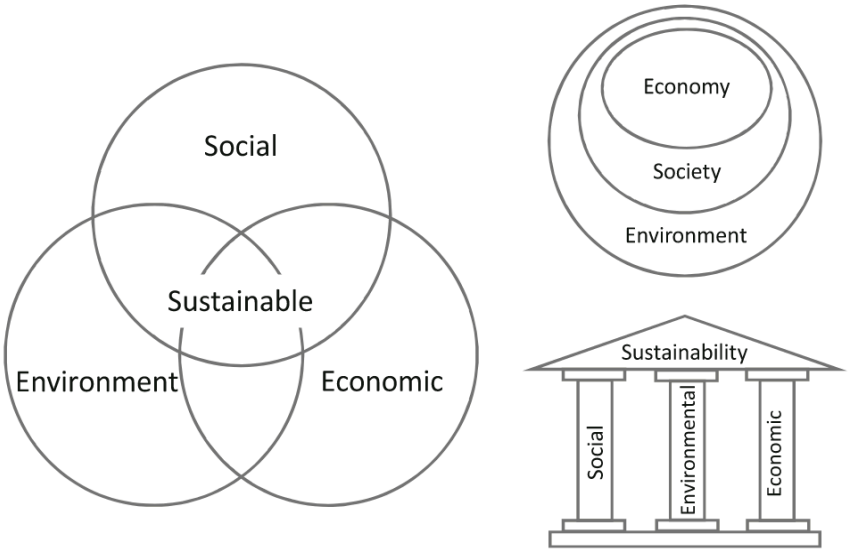

FIGURE 2 Representations of sustainability (Purvis et al., 2019, p. 682)

Despite the existence of the above-described framework, it is important to take into account that the meaning of sustainability ultimately depends on the views people pose to the current and future life, in other words, on their values (Waas

et al., 2011). Values can be defined as abstract and emotionally charged ideals that define people's goals and attitudes and provide standards that can be used to judge the behaviour of individuals and societies (Leiserowitz et al., 2006). While attitudes stand for the evaluation of an object, quality, or behaviour in terms of positive or negative, behaviour refers to individuals' and groups' decisions and actions stemming from underlying values and attitudes (Leiserowitz et al., 2006). Goals and values, in addition to world views and emotions, originate the motivations and methods for pursuing and maintaining sustainability (Ives et al., 2020). Thus, societal and normative choices that build from culturally and temporally dependent values are always implied in sustainability (Waas et al., 2011). Therefore, the realm of culture where individual and collective meanings are construed and negotiated poses a significant societal arena in which sustainability comes to be (Hammond, 2020). In other words, change in sustainability discourse and the language used in it may challenge and thus influence the currently expressed and reinforced paradigms relating to sustainability (Ives et al., 2020).

In sum, as stated by Hammond (2020), sustainability can be concluded to stand for a normatively desirable response to constantly transforming socio-ecological conditions. That is, the creation of a meaningful and prosperous future for societies even in unpredictable ecological conditions (Hammond, 2020). It is inherently political and context-specific (Purvis et al., 2019) and shaped by societal values (Leiserowitz et al, 2006; Waas et al., 2011). The United Nations has been a key entity in giving sustainability a universal definition through the framework of the three dimensions, namely environmental, economic, and social (Moldan et al., 2012; Purvis et al., 2019; Rout et al., 2020). Notwithstanding, sustainability can be considered as "a process of continuous reflexivity and transformation" (Hammond, 2020, p. 188) that benefits from an open and reflexive societal evolution. This is a process in which political grammars shaping and constraining conceivable social reality are challenged by inclusive socio-political places allowing diverse meanings and novel societal visions of sustainability (Hammond, 2020). Indeed, extending the ternary base of the concept, the dimensions of temporal, developmental, confidence, and compromise can be seen of interest in the sustainability discourse as well (Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012). This is an aspect that is explored more in detail in the following section.

Consumer understanding of sustainability

Providing a window into the meanings of sustainability found from individual minds, the field of consumer studies provides beneficial references on how understandings of sustainability have been observed in the consumer context. This context provides a bridge between linguistics and the context of technology, given that in many cases technology can be seen as a consumer product or service providing methods for people to achieve their goals (Saariluoma et al., 2016). Therefore, this description can be seen to be in line with the objective of the current study. Next, studies investigating consumer perceptions of sustain-

ability are reviewed with an eye on the salient dimensions used to make sense of the concept of sustainability.

Investigating Norwegian consumers' understandings of the concept of sustainability, Hanss and Böhm (2012) found that while sustainability was conceptualized mainly through the environmental dimension (associations dealing with topics such as nature, resource preservation, and nature preservation), the social (topics such as societies and government, values and attitudes, developing countries, and politics) and the developmental (topics such as development, technology, and research) dimensions were also particularly outstanding. Furthermore, all three were frequently addressed together in the associations of the participants of the study. This led them to a conclusion that the core elements constituting people's understanding of sustainability may be the environmental, the social and, the developmental dimensions, leaving the temporal (associations dealing with topics such as long-term perspective and future generations) and the economic (topics such as economics and economic welfare) dimensions to the periphery. Importantly, all the assigned dimensions appeared in people's understanding of the concept (Hanss & Böhm, 2012).

In a similar manner, in North America Simpson and Radford (2012) found that consumer perceptions of sustainability were strongly influenced by the environmental dimension (associations dealing with topics such as resources, environment, and waste). In contrast to the results obtained by Hanss and Böhm (2012), the authors found that the temporal dimension held an important position in people's conceptions; time manifested in the associations either as sustaining, that is, sustainability standing for a long-term societal orientation where concern was on the wellbeing of the future generations, or as durability reflecting a long-lasting quality of a product seen better for the environment. These dimensions were followed by the social (associations dealing with topics such as fairness, local and global issues, ethics and safety) and the economic (topics such as money, profit, and economy) dimensions, which, however, usually appeared interdependently with the environmental dimension. Furthermore, when sustainability was considered in a product context, it was related to dimensions of compromise (sustainable purchasing necessitates a compromise) and confidence (confidence or scepticism in the cause, the company or product, or the effectiveness the product would make). The obtained results showcased that while some understand the dynamic nature of sustainability for most it is realized in a unidimensional manner through environmental aspects (Simpson & Radford, 2012).

More recently, a study conducted by Barone et al. (2020) investigating Brazilian consumers' understanding of sustainability came to the same conclusion as the previous authors relating to the dominant role of the environment in the perceptions of people. In this study, most of the associations made related to the environmental dimension (associations related to topics such as conservation, recycling, and environment), followed by the dimensions of health and nutrition (topics such as health and traditional foods), productivity (topics such as economy and quality), and nourishment. Less salient dimensions that were associated with the concept were policy, science and technology, organic production, equilibrium, future, behaviour, and benefits. Moreover, sustainability

was associated with quality. The differences in dimensions were explained by demographics; the authors concluded that the younger participants with a higher education obtain a broader representation of sustainability in which environmental, societal, and economic dimensions are salient, thus representing a view on sustainability that is present in the abovementioned studies as well. On the other hand, the study also showed that sustainability can be understood merely through the dimension dealing with health and nutrition. This highlights the fact that even though the sustainability concept enjoys increased global attention, also those unaware of its designated meaning still exist (Barone et al., 2020).

These three studies conducted in different parts of the world at different times show that the understanding of sustainability seems to be strongly biased in the direction of the environment despite the different cultural contexts in which the studies were conducted. That is, sustainability is primarily associated with aspects that relate to the environment such as nature, resource preservation, and biodiversity (Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012). Thus, the more holistic version of the sustainability concept seems not to be entirely evident in the representations of consumers. Hanss and Böhm (2012) as well as Simpson and Radford (2012) reason this to be the fault of media, research, and practice that have enforced sustainability as mainly an environmental phenomenon. As Mulder et al. (2011) explain, simplification of concepts is common in media given that complex terms may be difficult to communicate to the general public, an act that further reinforces public perceptions and thus decreases the likelihood to see a concept holistically. In the case of sustainability, the interest in specific aspects varies depending on events taking place on Earth (Mulder et al., 2011). Recently, many of those events can be seen to have focused on environmental aspects such as climate change and biodiversity challenges providing a somewhat straightforward and more accessible focus point for many. It could also be that environment as an observable, measurable, and reportable element may be perceived as more convenient for research, practice, and media than the other aspects within sustainability as they deal with perhaps more complex socio-economical themes and topics.

Finally, by implementing the triatic foundation for sustainability in their conceptualizations, the reviewed studies show that the starting point for understanding the concept seems to be the UN's definition. This definition comprises environmental, economic, and social dimensions and allows for little clearance. Nonetheless, as seen above, the dimensions of time and development also become relevant in people's understanding of sustainability, in addition to compromise and confidence. Therefore, within this thesis, sustainability is outlined to consist of seven dimensions described in the paragraphs before: *environmental, social, economic, temporal, developmental, confidence,* and *compromise*. With this basis, the inspection is next turned to sustainability as presented in the discourse found from the field of human-computer interaction.

3.2 Sustainability and Human-Computer Interaction

Societies depend on technology as it is intrinsically part of both human communities as a whole, as well as the individual lives of the members of those communities (Mulder et al., 2011). Accordingly, technology emerges within a sociocultural setting which further shapes and implements its values (Stahel, 2011). When it comes to sustainability, however, technology can be seen to embody a contested role. That is, while it is seen to be partly at fault in creating the current global challenges it is also considered to play a significant role in solving them (Mulder et al., 2011). Here, information technology is a good example. In the Global North, information technology is integrated into the everyday lives of people to a great extent (Mankoff et al., 2007). That is, information technology is basically everywhere to help people with a wide range of tasks varying from banal to highly specific. Therefore, this everyday technology may provide an effective way to influence the everyday decisions and mindsets relating to sustainability challenges (Mankoff et al., 2007). Nonetheless, questions relating to technology initiatives striving for sustainability remain, especially regarding the actual social and environmental impact they would bring in long-term as well as whether a technology intended to solve sustainability challenges despite its original aim ends up aggravating other problems or creating new ones (Mulder et al., 2011). That being, the effects of technology do not depend merely on inherent characteristics of a given technology, but, for instance, also on the way a technology is perceived and used in a social context and the way it affects or even transforms this context (Mulder et al., 2011). Thus, there is a need to "spark a shift in thinking about technology's role in affecting radically positive change" (Knowles et al., 2018, p. 7). As Mulder et al. (2011) point out, no straightforward technological fix for sustainability exists; it is the institutions, systems and personal lives that have to change, because in the end technology and society are tied in that they inherently co-evolve. In other words, technological change creates social change which in turn triggers new needs and conditions for technology. Therefore, the development of sustainable technology requires dynamic reflection, learning, and interaction with stakeholders (Mulder et al., 2011), who can actually be considered "a latent force for good" in the quest of achieving sustainability (Knowles et al., 2018, p. 6).

A research field responsible for the investigation and design of interaction between people and technology is known as human-computer interaction (HCI). Essentially HCI seeks to bring a multidisciplinary take on technology design with a focus on knowledge about the people it is being designed for (Sutcliffe, 2000). Research from this field offers significant knowledge to a vast range of designers aiming to create technology that is meaningful to people and serves them in their goal-oriented actions (Saariluoma et al., 2016). Accordingly, ways to contribute solutions to the challenges of sustainability has become an essential theme in the HCI community (DiSalvo et al., 2010). However, the nature of these contributions is contested. In other words, those in the community showing interest to sustainability struggle with how to utilize technology design to build social change (Håkansson & Sengers, 2014). Currently two competing

views exist in regards to HCI's role in sustainability: the first, where small corrective acts concerning energy consumption and people achieving their goals is considered sufficient, and the second, where significant changes to the current lifestyle are seen as mandatory in order to sustain the quality of life for the current and future generations (Knowles et al., 2018). These views have taken form over the years as the subfield of sustainable HCI (SHCI) has evolved from the seminal work of both Blevis (2007) and Mankoff et al. (2007).

Blevis (2007) sees that sustainability should present the core of interaction design in that it should be used as a critical lens through which interactive systems are be designed. This critical thinking can be considered crucial for the collective futures. Furthermore, the author points out the material effects of technology and its intimate connection to obsolescence with implications to sustainability. The author further proposes a set of guidelines for sustainable interaction design that are focused on reducing these effects directly and indirectly, thus having an effect on environmental sustainability (Blevis, 2007). Meanwhile, Mankoff et al. (2007) position sustainability in the field of HCI in a dual manner: sustainability *in* design and *through* design, a dichotomy that has been widely adopted in the SHCI community (DiSalvo et al., 2010). Sustainability in design takes sustainability and places it in relation to the material design of different products, whereas supporting sustainable lifestyles and decision-making throughout technology design is the focus of sustainability through design (Mankoff et al., 2007). In this sense, sustainability in design is a more direct approach providing a solution in the actual design, while sustainability through design can be seen to demand a change of behaviour, practices, or actions via the end-product (Remy, 2017). Similar to Blevis (2007), Mankoff et al. (2007) reference the relevance of SHCI to environmental sustainability rather than sustainability challenges holistically.

Despite a considerable boom in the area after the aforementioned papers (DiSalvo et al., 2010) and often adopted aim of contributing to a sustainable future more practically instead of simply advancing technology (Remy & Huang, 2017), much of the work in SHCI has stayed within the borders of the research community (Remy & Huang, 2017; Remy, 2017). This effect, also known as the theory-practice gap (e.g., Sutcliffe, 2000) may have limited the impact of the field (Remy, 2017). Accordingly, not all see that the work within SHCI has been up to the degree of urgency that sustainability initiatives require. In their rather recent paper, Knowles et al. (2018) argue that the slowness that has occurred in trying to define sustainability and deciding which direction SHCI should pursue has arrived at a point in which bold and radical action is seen necessary to have a reasonable chance of attaining any significant and long lasting change. Thus, the previously favoured scattered research about minor actions in energy consumption and other human behaviour are no longer seen enough to sustain human futures. In other words, the interest has shifted from individual technologies to questions on how to make the complex computing industry sustainable (Knowles et al., 2018).

In particular, Håkansson & Sengers (2014) have identified five dilemmas that HCI designers struggle with when it comes to creating opportunities for making change for sustainability. While they map issues that arise in SHCI,

they are also inherent to change making and the complex challenge of sustainability (Håkansson & Sengers, 2014). First, the authors see that constant rethinking is needed for making change. This means that problems are rethought in order to make progress which, however, may sometimes get in the way of making progress at all. This is due to the fact that this act is an exhaustive process for both research and the field. Second, most of the change that occurs is small at scale despite probably having finite impact in the world, while HCI has been interested in large-scale interventions and big-impact change. Third, it appears that there is no end point in the need to make change. In other words, no finality seems to exist regarding the change needed, or when enough would have been done successfully. Rather, change and its need are in a constant flux. Fourth, the authors state that sustainable change requires attention to sustaining change making rather than focusing merely on the obtained results. This stands to mean that oftentimes HCI designers' work comes down to providing more immediate results instead of working on effective long-lasting social change. Here, inflexible operational and organisational frameworks may be at fault. And finally, fifth, they point out that change is conditioned by the current system which means that there are compromises that manifest in the contexts of change making. For sustainable HCI this may manifest in the dilemma of designing new sustainable technologies that help to save resources, but that actually require resources themselves. To address these challenges the authors suggest that SHCI needs to reconfigure the role of old and new, embrace diverse motivations for change, recognize and work with the on-going flow in change, increase the sustainability of what they do with the help of emotions, education and diversification to, and finally, address change from the perspective of communality (Håkansson & Sengers, 2014).

Accordingly, Knowles et al. (2018), reflecting on the writer Naomi Klein's (2014) work *This Changes Everything: Capitalism vs The Climate*, pose six takeaways or guidelines to redirect sustainable HCI research. These guidelines presented by the authors are as follows. First, SHCI needs to orient around climate change rather than sustainability as it provides a more solid narrative to unify the community in their activities. Second, SHCI needs to develop a new model for the digital economy, one that is more sensitive to the aspects underlying people's use of technologies than the current corporate profit. Third, it is essential for SHCI to fight injustice and inequality on all fronts. Fourth, SHCI needs to help to build and support a mass movement that is facilitated with technological communication means. Fifth, SHCI needs to foster a values-based debate via technological means but also in the research community. Finally, SHCI needs to brace for impact in that it needs to come up with solutions that enable preparedness for worst-case scenarios with technological solutions that can endure the extreme conditions. The authors further show how these take-aways are already taking place within the field, thus enforcing this common narrative by presenting previous research focused on topics such as systems thinking, computing within ecological limits, future proofing, confronting the economy, supporting local communities and infrastructures, advocating social justice, inspiring with future visions, reimaging (digital) civics, and embracing and accounting for the political. Thus, it can be considered that currently in the field of

HCI sustainability is seen as a more holistic ideal instead of one defined by the three main dimensions of ecological, economic and social (Knowles et al., 2018). Moreover, the focus has shifted from affecting individual actions to affecting existing constructs. Thus, drawing from these implications the following dimensions can be identified: *environmental*, *social*, *economic*, *temporal*, *developmental*, and *political*. It is therefore these dimensions that are seen particularly present in the sustainability discourse in the field of sustainable human-computer interaction.

In sum, looking at how sustainability is voiced in the field of HCI some points are evident. First, while the importance to act to sustain the current quality of life has been well-recognized within the HCI community, the methods to do so remain scattered. This may result in several independent actions with varying motivations towards a plethora of domains hindering comprehensive collective action. Sustainability has thus proven a challenge to the discipline that can be seen inherently progressive (Håkansson & Sengers, 2014). This can further be seen problematic as designers of technology may be left with significant responsibilities in terms of the short and long-term effects of their designs on societies (Mulder et al., 2011). Furthermore, the potential of changing the behaviour of people through technology has been a significant theme in SHCI research (Froehlich et al., 2010). Recently, however, the focus has shifted from technological interventions targeted in this direction to ways in which technologies may support people as part of communities and as a citizen in their quest to fight, survive and thrive (Knowles et al., 2018). Given this, it could be argued that sustainability is seen as something more than a mere product attribute used to induce desired – and designer determined – behaviour. In line with the importance of cultural shift needed for sustainability mentioned in the previous subchapter, also Knowles et al. (2018) see that "the kinds of SHCI activities that seem to meaningfully contribute toward sustainability are not those that *solve* well-defined problems, but rather those that *contribute* more subtly to a shift in culture or power" (p. 7, emphasis in original).

4 RESEARCH DESIGN AND METHOD

This chapter introduces the research design and methods used to conduct the current study serving as a foundation for the results presented in the following chapter. Particularly, the current chapter displays the empirical segment of the thesis that aimed to investigate how the concept of sustainability is understood when it is conjoined to the context of technology. As an additional aim, it sought to observe whether sustainability is perceived as important for technology. These objectives were approached by implementing a questionnaire study that is presented in detail in the following subchapters. More precisely, the first part of this chapter displays the research focus outlined from the literature presented in the previous chapters. Then, the design of the study and the instrument used in it are described. Finally, a presentation of the procedure and participants of the study bring the chapter to an end.

4.1 Research Focus

International officials and policymakers have a great influence on how sustainability is defined and understood. This understanding is transferred to the consciousness of the general public via various means in various contexts. While these normative official conceptualizations exist, it is of interest to understand how the general public makes sense of the concept. Individual understandings may vary in terms of how salient and important distinct dimensions of sustainability are considered. Accordingly, a segment of previous studies has investigated how consumers understand the concept of sustainability. In particular, they have shown that while consumers may understand sustainability as a multidimensional entity, it is still most strongly associated with the environmental dimension having to do with topics such as nature, resource preservation and biodiversity (Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012). Interested in extending the study of how sustainability is understood, this thesis shifts its investigation to the context of technology. Indeed, sustainability is increasingly researched and implemented in the design and develop-

ment of technology, not least in the field of HCI (DiSalvo et al., 2010). Accordingly, the topic of sustainability has sparked several distinct research directions and methods within HCI. This plurality while expressing the holistic nature of sustainability has also proved problematic for the community trying to position itself in terms of creating opportunities for sustainability (Håkansson & Sengers, 2014). In other words, while efforts to unite the community exists, the HCI field has not yet found a way to unite behind a common cause for sustainability (Knowles et al., 2018). Given that such uncertainty rests among those dealing with matters relating to sustainability and technology design, it cannot be but wondered as to whether the same ambiguity is present among the general public whose everyday lives these technological sustainability initiatives aim to alter. This is why it is seen of value to investigate the concept of sustainability in this particular context, something that according to the knowledge of this thesis lacks an observation from the perspective of individuals in the general public. Specifically, this thesis finds it meaningful to observe not only how sustainability is understood in the context of technology in terms of salient dimensions, but also whether it is perceived as important for technology. These interest points are further approached by investigating the possible effects of the experiences and awareness relating to sustainability, that is, the effects of sustainability consciousness. The questionnaire study based on this research area is next presented in more detail.

4.2 Design and Instrument

In order to carry out the questionnaire, the survey and reporting tool Webropol 3.0 (Appendix 2) was used. Specifically, the questionnaire was made of 23 questions comprising seven sections: 1. sustainability associations; 2. context of technology where the term "sustainability" was last encountered; 3. sustainability consciousness; 4. context and interlocutors relating to sustainability thoughts and discourse; 5. importance of sustainability dimensions' attributes for currently used technology; 6. importance of sustainability for technology; and 7. notions of sustainability and technology from before. Importance of sustainability dimensions' attributes (5.) was observed from the following dimensions: environmental, social, economic, temporal, developmental, confidence, and compromise. Importance of sustainability for technology (6.), on the other hand, was conceptualized to consist of the following dimensions: environmental, social, economic, temporal, developmental, and political. The selection of dimensions was based on the identified dimensions found from the literature described in the previous chapter. Specifically, the literature relating to consumer understanding of sustainability for section 5. and the literature relating to how sustainability may be made sense in the HCI-community for section 6.

In the first section, the participants were asked to write down in open-end fields the five first associations that come to their mind from the provided terms "sustainable development" and in the next part "sustainable development" and "technology". As explained by Son et al. (2014), "based on an associative net-

work conceptualization of memory structure, the free word association task reflects the relative strength of automatic associations between concepts for a population of individuals" (p. 39). In other words, when a prompted stimulus word - such as *owl* - produces an association to another word – such as *wise* – among several individuals in a given population or group, the words are seen strongly associated with one another. These strong associations between words are often observed within groups of individuals sharing commonalities arising from similar experiences (Son et al., 2014). Therefore, in the given example, the stimulus word *owl* strongly associated with the word *wise* would indicate that the observed group of individuals share the same experience of thinking owls as wise, for instance arising from a TV show broadcasted in that area in their childhood. Given that the association method is commonly used in studies investigating concepts in terms of their mental representations (e.g. Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012; Son et al., 2014) the use of it was considered relevant also in the current study.

Moving on with the questionnaire design, in the third and sixth section, the sustainability consciousness of the participants and the importance of sustainability for technology were measured with a 5-point Likert-scale (1 = *Strongly disagree*, 2 = *Disagree*, 3 = *Neither agree nor disagree*, 4 = *Agree*, 5 = *Strongly agree*). The use of Likert-scale is commonly used method to measure the attitudes of people (Vehkalahti, 2019, p. 35). In the fifth section, the importance of sustainability dimensions' attributes was investigated by asking the participants to rank seven four-item sets in order of importance, respectively, with a scale of 1-4 (1 = *Most important*, 2 = *The second most important*, 3 = *The third most important*, 4 = *The fourth most important*). Ranking method can be used in estimating preferences or choices among a set of items and in particular highlighting priorities among the choice set (Fabbris, 2013). Thus, in order to detect the most important sustainability attribute the method was selected.

In addition, the questionnaire included three open-ended questions (sections 2., 4. & 7.). Answers to open-end questions may provide otherwise undetectable valuable information about the phenomenon being measured (Vehkalahti, 2019, p. 25), which is why they were also included in the current study. The first inquired the most recent context where participants had encountered the term sustainability in relation to technology, whereas the second asked about the context where sustainability was thought about and discussed with others. The third open-ended question inquired if participants had previously thought about sustainability in relation to technology and encouraged them to describe their experience in more detail.

Finally, the main questions were accompanied with a section inquiring some demographic details of the participants. Presented in the beginning of the questionnaire, participants were required to indicate their individual details comprising of gender, age, municipality of residence (in Finland), education (either current or highest degree), life situation and lingual details (first language, main language used at a work-setting, and main language used on free time). The following Table 1 presents the questionnaire sections and their subsections alongside with question numbers. Furthermore, the question types are indicated in the table under each section.

TABLE 1 Questionnaire sections and subsections

Section	Subsection	Question
1. Sustainability associations *(Open-end)*	• Sustainability • Sustainability and technology	1 2
2. Context of technology where the term "sustainability" was last encountered *(Open-end)*		3
3. Sustainability consciousness *(Structured)*	• Knowingness • Attitudes • Behaviors	4–6
4. Context and interlocutors relating to sustainability thoughts and discourse *(Open-end)*		7
5. Importance of sustainability dimensions' attributes for currently used technology *(Ranking & open-end)*	• Environmental • Social • Economic • Temporal • Developmental • Confidence • Compromise	8-21
6. Importance of sustainability for technology *(Structured)*	• Environmental • Social • Economic • Temporal • Developmental • Political	22
7. Notions of sustainability and technology from before *(Open-end)*		23

This thesis used a previously validated questionnaire to investigate participants' consciousness towards sustainability. In particular, Gericke et al. (2019) have developed a theoretically grounded and empirically validated questionnaire that measures individuals' sustainability consciousness (SCQ). The concept of sustainability consciousness is defined as "an individual's experience and awareness of sustainable development" (p. 35), in other words people's experiences and perceptions of sustainability commonly associated with themselves including beliefs, feelings and actions (Gericke et al., 2019). The questionnaire is based on UNESCO's (e.g., 2014) definitions of sustainability covering 15 UNESCO subthemes through three dimensions of sustainability: environmental, societal and economic. As Gericke et al. (2019) explain, by including the constructs of knowingness, attitudes, and behaviour, the questionnaire takes a holistic approach to investigate cognitive and affective views of sustainability. SCQ-S (a short version of the questionnaire), on the other hand, measures "the second order constructs of sustainability knowingness, sustainability attitudes and sustainability behaviour" in addition to sustainability con-

sciousness (Gericke et al., 2019, p. 35). This scale in its comprehension measures the concept of sustainability in a way that it can be used "as an instrument to investigate and evaluate people's perceptions of various kinds of efforts regarding the promotion and evaluation of sustainable development through policy, communication or education" (Gericke et al., 2019, p. 36). Given that the authors recommend the short version for large-scale studies evaluating sustainability consciousness alongside with sustainability knowingness, attitudes and behaviour, it was chosen over the long version of the questionnaire. Furthermore, the length of the SCQ-S with only 27 items was considered more appropriate for the objective of this study than the longer version with 49 items as it has been shown that longer questionnaires may increase participant carelessness undermining data quality (Bowling et al., 2020), for instance.

4.3 Procedure and Participants

This subchapter introduces the procedure of the study and its participants. Starting with the procedure, data for the study was collected via an online survey in October 2020. First, the survey was distributed to the students and personnel of University of Jyväskylä via email lists. After that, the personal email account of the author was used to send the questionnaire link further. It was also made clear in the invitation letter that the survey could be distributed freely onwards by single participants. The questionnaire was answered anonymously. After completing the survey questionnaire, the participants had a possibility to participate in a raffle of convenience store gift cards in a separate questionnaire form.

Altogether 235 participants completed the survey. One hundred forty-three (60.9 %) of the participants were women and 81 (34.5 %) men. Three participants replied to be of other gender or preferred to self-describe their gender (1.3 %). Moreover, eight participants did not want to reply (3.4 %). The participants were mainly between 18 to 34 years old (88.1 %). The median age was 26 years with the youngest participant at 19 years of age and the oldest at 73 years of age. Almost all participants resided in major cities in Finland (total of 92.4 %). Regarding education, 105 participants stated to have a lower (44.7 %) and 102 higher or doctoral degree (43.4 %), or they were currently completing it. When asked about their current life situation, majority of the participants stated to be students (74.0 %) while 44 participants answered to be working (18.7 %). Finally, the linguistic details showed that almost all participants' first language was Finnish (97.9 %), while their stated languages used at work varied between Finnish (84.7 %), English (23.0 %), and Swedish (0.4 %). During their free time, participants used mainly Finnish (92.8 %) or English (9.4 %) in addition to other languages (total of 3.5 %). The aforementioned demographic details are presented in Table 2.

TABLE 2 Participant demographics

Demographic variable	**n**	%
Gender		
Women	143	60.9
Men	81	34.5
Other / Prefer to self-describe	3	1.3
Do not want to reply	8	3.4
Age group		
18-24	100	42.6
25-34	107	45.5
35-44	15	6.4
45-54	5	2.1
55-64	7	3.0
65-74	1	0.4
Type of residing municipality in Finland*		
Do not live in Finland	1	0.4
Rural municipality	8	3.4
Densely populated municipality	7	3.0
Urban municipality	2	0.9
Major city with <100 000 inhabitants	4	1.7
Major city with 100 000-500 000 inhabitants	195	83.0
Major city with >500 000 inhabitants	18	7.7
Education		
Secondary school	28	11.9
Lower academic degree	105	44.7
Higher academic degree	99	42.1
Doctoral degree	3	1.3
Life situation		
Working	44	18.7
Unemployed	5	2.1
Stay-at-home parent	4	1.7
Student	174	74.0
Retired	1	0.4
Other*	7	3.0
First language*		
Finnish	230	97.9
Swedish	2	0.9
Catalan	1	0.4
Japanese	1	0.4
Russian	1	0.4
Thai	1	0.4
Language used at work*		
Finnish	199	84.7
English	54	23.0
Swedish	1	0.4
Language used on free time*		
Finnish	218	92.8

(continues)

Table 2 (continues)

English	22	9.4
German	2	0.9
Spanish	2	0.9
Swedish	2	0.9
Japanese	1	0.4
Russian	1	0.4

Regarding the demographics marked with an asterisk presented above (Table 2), few clarifications are made. First, in the demographic section 'Type of residing municipality in Finland' the municipalities attained from the questionnaire data were coded into classifications of municipalities according to Finland's Ministry of Finance's publication (2020, pp. 326-335) with a modification regarding major cities that were divided into three distinct types based on their population. This was done to make the category 'Major city' more representative in terms of the size of the population. Second, the participants who chose the alternative 'Other' (n=7) in the demographic section of 'Life situation' were asked to specify their selection. All seven stated to be currently both working and studying. Of these four participants specified to be working part-time. Finally, in the sections relating to languages, some participants indicated more than one language per section, thus providing an answer including a combination of languages that were seen relevant. All distinct mentions of languages were coded into their respective categories and thus indicate a higher n of total answers in the above table. However, attempting to keep the answers representative in terms of the languages being used, the percentages were calculated in relation to the total amount of participants (*N*=235).

5 DATA ANALYSIS AND RESULTS

The questionnaire survey introduced in the previous chapter aimed to provide insight into how people make sense of the sustainability concept in the context of technology. In the current chapter, the analysis of the data and the main findings are displayed. In particular, the first two subchapters present the analysis of the data (*N*=235) accumulated in October 2020 mainly via email lists and personal email, and the survey results. Following this, the third subchapter presents an evaluation of the validity and reliability of the analysed findings. The results are discussed in the following chapter six.

5.1 Analysis

The analysis of the survey data was carried out with IBM SPSS Statistics 27. Specifically, this analysis concerned the data obtained from the structured question sections included in the questionnaire including the rank-order section. The association element and the three open-ended questions, in turn, were analysed using a method of quantitative content analysis. That is, the answers were approached through quantitative classification. In other words, quantitative classification aims to describe the content of the obtained data in a quantitative manner, for example by extracting and reporting the instances of particular words (Tuomi & Sarajärvi, 2004). In particular, the data from the association element was coded for the appearance of the seven sustainability dimensions presented in the previous chapter. This was done to determine which dimension was the most salient in participants' answers in both of the association parts and also to see whether the theoretical conceptualization of sustainability was salient to the participants. All the associations and open-ended questions were analysed based on their relevance to the current study, thus absent and irrelevant information was left out. The results obtained from both the content analysis and structured questions were first observed alone and then reflected together.

Reliability of the sum variables

In order to reliably analyse the variables distilled from the data, a reliability analysis was carried out to the structured survey statements grouped beforehand (Table 2). This measurement was done with the use of Cronbach's alpha (α), which is a widely acknowledged mean to measure variable reliability (Metsämuuronen, 2011, p. 544). The reliability measures indicated that five sum variables exceeded the accepted value of .700. In terms of the validated SQC-S questionnaire (Gericke et al., 2019) this was expected. The qualified sum variables are presented in the Table 3.

Contrary to the original aim, the section of importance of sustainability for technology consisting distinct subsections concerning importance of environmental (α = -.150), social (α = .569), economic (α = .136), temporal (α = .107), developmental (α = .471), and political (α = .385) dimensions were not formulated into respective sum variables because of their low reliability. In other words, their α-values were under .600. Given this, all of the 18 variables were inspected with a factor analysis that was deemed appropriate given the sufficient N. The factor analysis suggested that 10 of the variables were measuring the same underlying factor, that is, importance of sustainability for technology. Moreover, the sections selected for the sum variable also seemed to describe the intended construct in terms of content. Therefore, further reliability measures were implemented with Cronbach's alpha. The results indicated that the new 10-item sum variable exceeded the accepted value of .700. Thus, the sum variable was qualified for analysis. A list of the unqualified variables is presented in Appendix 1.

TABLE 3 Qualified sum variables

Sum variable	**alpha (α)**
Sustainability knowingness (Gericke et al., 2019) 4.1 (Env.) *Reducing water consumption is necessary for sustainable development.* 4.2 (Env.) *Preserving the variety of living creatures is necessary for sustainable development (preserving biological diversity).* 4.3 (Env.) *For sustainable development, people need to be educated in how to protect themselves against natural disasters.* 4.4 (Soc.) *A culture where conflicts are resolved peacefully through discussion is necessary for sustainable development.* 4.5 (Soc.) *Respecting human rights is necessary for sustainable development.* 4.6 (Soc.) *To achieve sustainable development, all the people in the world must have access to good education.* 4.7 (Eco.) *Sustainable development requires that companies act responsibly towards their employees, customers and suppliers.* 4.8 (Eco.) *Sustainable development requires a fair distribution of goods and services among people in the world.* 4.9 (Eco.) *Wiping out poverty in the world is necessary for sustainable development.*	.806

(continues)

Table 3 (continues)

Sustainability attitudes (Gericke et al., 2019) 5.1 (Env.) *I think that using more natural resources than we need does not threaten the health and well-being of people in the future.** 5.2 (Env.) *I think that we need stricter laws and regulations to protect the environment.* 5.3 (Env.) *I think that it is important to take measures against problems which have to do with climate change.* 5.4 (Soc.) *I think that everyone ought to be given the opportunity to acquire the knowledge, values and skills that are necessary to live sustainably.* 5.5 (Soc.) *I think that we who are living now should make sure that people in the future enjoy the same quality of life as we do today.* 5.6 (Soc.) *I think that everyone throughout the world must be given the same opportunities for education and employment regardless of their gender.*** 5.7 (Eco.) *I think that companies have a responsibility to reduce the use of packaging and disposable articles.* 5.8 (Eco.) *I think it is important to reduce poverty.* 5.9 (Eco.) *I think that companies in rich countries should give employees in poor nations the same conditions as in rich countries.*	.797
Sustainability behaviors (Gericke et al., 2019) 6.1 (Env.) *I recycle as much as I can.* 6.2 (Env.) *I always separate food waste before putting out the rubbish when I have the chance.* 6.3 (Env.) *I have changed my personal lifestyle in order to reduce waste (e.g., throwing away less food or not wasting materials).* 6.4 (Soc.) *When I use a computer or mobile to chat, to text, to play games and so on, I always treat others as respectfully as I would in real life.* 6.5 (Soc.) *I support an aid organization or environmental group.* 6.6 (Soc.) *I show the same respect to all genders regardless of their age.**** 6.7 (Eco.) *I do things which help poor people.* 6.8 (Eco.) *I often purchase second-hand goods over the internet or in a shop.* 6.9 (Eco.) *I avoid buying goods from companies with a bad reputation for looking after their employees and the environment.*	.765
Sustainability consciousness (Gericke et al., 2019) Sustainability knowingness Sustainability attitudes Sustainability behaviors	.883
Importance of sustainability for technology 22.1 (Env.) *New technology must enable a high life quality also in those areas that will be most affected by natural disasters caused by climate change.* 22.2 (Soc.) *New technology must eliminate injustice and inequality in all areas of live.* 22.3 (Soc.) *New technology must be developed according to different values than before, because people's values have changed.* 22.4 (Eco.) *The success of new technology can be measured also non-financially.* 22.5 (Eco.) *Instead of financial gain, social well-being must guide the development of new technology.* 22.6 (Tem.) *New technology must already now be developed according to the principle that natural resources will be used up in the future.* 22.7 (Dev.) *The development of new technology must comprehensively take*	.797

(continues)

Table 3 (continues)

account of its effects on both individual and societal level. 22.8 (Dev.) *People in local communities must be included in the design process when designing new technology for them.* 22.9 (Dev.) *New technology must enable and support communication and action between people in a way that supports global mass activism and democracy.* 22.10 (Pol.) *New technology must allow existing power structures to be called into question.*	

* Inverted item

** The original item *"I think that women and men throughout the world must be given the same opportunities for education and employment"* was modified to be inclusive for all genders.

*** The original item *"I show the same respect to men and women, boys and girls"* was modified to be inclusive for all genders.

Visually investigating the variables showed a poor fit to the normal curve which was further investigated via Kolmogorov-Smirnov and Shapiro-Wilk normality tests. The normality tests indicated that the variables do not follow a normal distribution. Therefore, the descriptive statistics in the next subchapter are reported with the use of medians instead of means. Given the non-normal distribution, the use of non-parametric tests was considered appropriate. Accordingly, the variables were analysed with the non-parametric tests of Mann-Whitney U, when the medians of two independent groups were investigated, and Kruskal-Wallis for the investigation of medians of groups of two or more (Metsämuuronen, 2011). Spearman correlation was implemented to investigate correlations between the variables. In addition, linear regression analysis was used to estimate the relationship of the variables. Finally, in order to observe the strength of the phenomena being measured, the effect sizes were measured with popularly used Cohen's d (Lenhard & Lenhard, 2016).

5.2 Results

This subchapter presents the survey results in respective sections: 1) sustainability consciousness, 2) context and interlocutors relating to sustainability thoughts and discourse, 3) notions of sustainability in relation to technology from before, 4) free associations to the term "sustainable development" and the terms "sustainable development" and "technology", 5) context of technology where the term "sustainability" last encountered, 6) importance of sustainability attributes for technology, and 7) importance of sustainability for technology. The presentation order of the results differs to that of the questionnaire in that here the sections relating to sustainability in general are presented first after which sections dealing with sustainability and technology follow.

Sustainability consciousness

This section represents the results relating to sustainability consciousness of the participants. To recap, the short version of sustainability consciousness ques-

tionnaire (Gericke et al., 2019) can be used to evaluate the consciousness of the participants in relation to sustainability as a construct of its own, but also on three levels: knowingness, attitudes and behaviour. These all are investigated through three sustainability dimensions, namely environmental, social, and economic. The questionnaire bases its items on UNESCO framework because of sustainability's definition's theoretical foundation that is globally recognized and used in various documents and guidelines. In this framework sustainability is defined as the interplay of the environmental, societal and economic dimensions and their subthemes, making it a holistic concept. In short, sustainability consciousness is built on the psychological constructs of knowingness, attitudes and behaviour related to sustainability (Gericke et al., 2019). For the current study, sustainability consciousness questionnaire offers a way to evaluate the participants' sustainability consciousness in addition to their knowingness, attitudes and behaviour in relation to sustainability possibly reflecting in their answers to the other parts of the survey questionnaire.

The first part of the sustainability consciousness section investigated participants' knowledge of sustainability. Based on the distribution of the sum variable displayed in Figure 3 participants had mostly a strong knowledge of sustainability (*Mdn* = 4.22). Women (*Mdn* = 4.44) showed stronger knowledge of sustainability than men (*Mdn* = 4.11). A Mann-Whitney U test indicated that this difference was statistically significant, Z = -3.3, p = .001. Cohen's effect size was small (d = .45). Accordingly, as pictured in Figure 4, within the current study women showed on average stronger knowledge of sustainability than men. Further statistical tests using Kruskal-Wallis K indicated no statistically significant differences among other demographics.

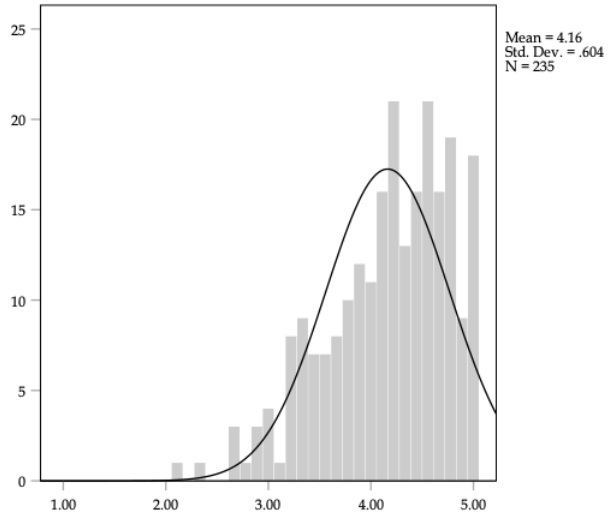

FIGURE 3 Distribution of sustainability knowingness

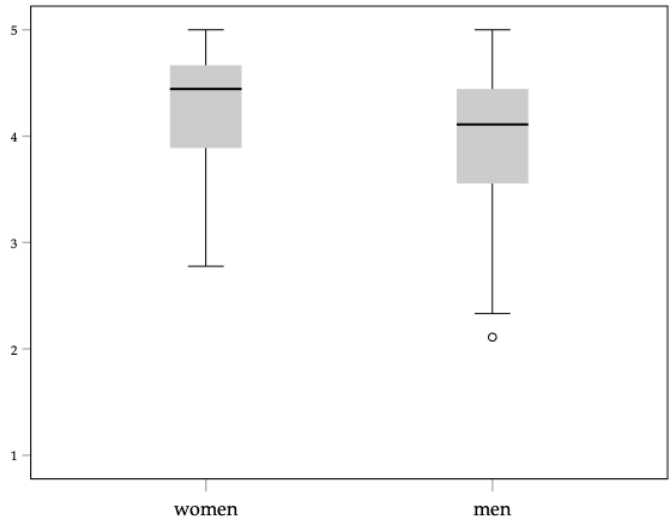

FIGURE 4 Gender-based medians of sustainability knowingness

The next sum variable aimed to observe participants' attitudes towards sustainability. The distribution of the sum variable displayed in Figure 5 shows that participants had a largely positive attitude towards sustainability (*Mdn* = 4.67), in other words sustainability was considered important. Here, too, women (*Mdn* = 4.78) showed a more positive attitude than men (*Mdn* = 4.44). A Mann-Whitney U test indicated that this difference was statistically significant, Z = -5.3, $p < .001$. Cohen's effect size was medium ($d = .75$). That is, within the current study women had on average a more positive attitude towards sustainability than men. The medians of the genders are pictured in Figure 6. Further statistical tests using Kruskal-Wallis K indicated no statistically significant differences among other demographics.

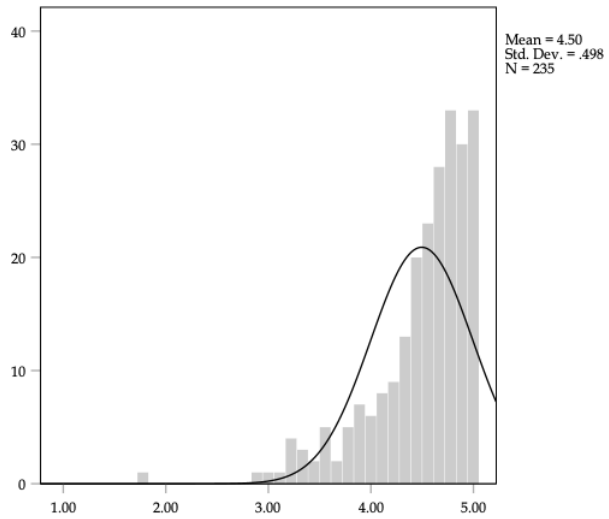

FIGURE 5 Distribution of sustainability attitudes

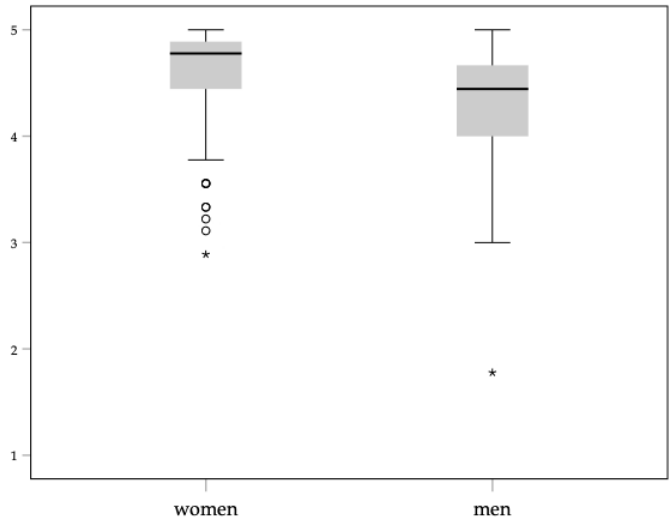

FIGURE 6 Gender-based medians of sustainability attitudes

The last variable of sustainability consciousness measured participants' behaviour in relation to sustainability. The distribution of the sum variable presented in Figure 7 indicates that within the current study, participants mostly considered themselves to undertake actions that contribute to sustainability (*Mdn* = 4.00). Women (*Mdn* = 4.11) scored higher in sustainability behaviour than men (*Mdn* = 3.67). A Mann-Whitney U test indicated that this difference was statistically significant, Z = -5.4, $p < .001$. Cohen's effect size was medium ($d = .77$). Accordingly, within the current study women evaluated on average their participation in sustainability behaviour to a greater extent than men. This is presented in Figure 8. Similar to the variables before, further statistical tests using Kruskal-Wallis K indicated no statistically significant differences among other demographics.

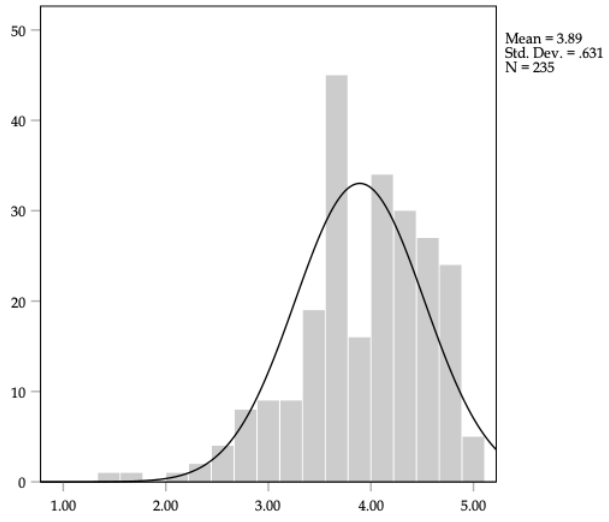

FIGURE 7 Distribution of sustainability behaviors

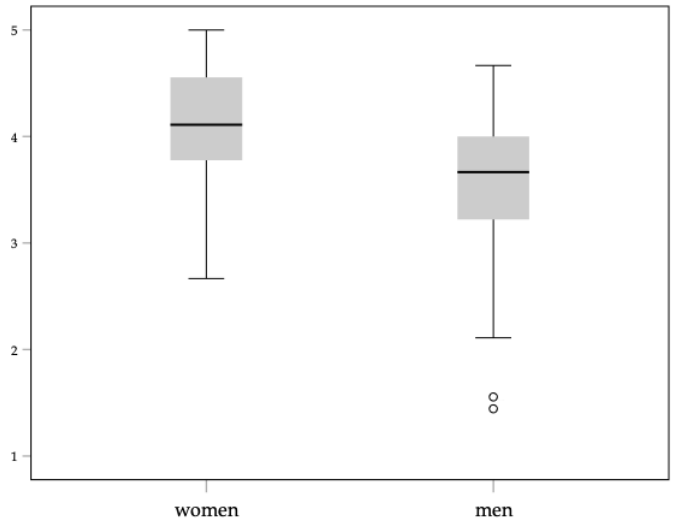

FIGURE 8 Gender-based medians of sustainability behaviors

Finally, the aforementioned three sum variables were constructed into one sum variable of sustainability consciousness. Reflecting the distribution of the previous variables, participants seemed to show a strong sense of consciousness towards sustainability (*Mdn* = 4.30). The distribution of the variable is displayed in Figure 9. Furthermore, the sustainability consciousness was higher with women (*Mdn* = 4.44) than men (*Mdn* = 4.07). A Mann-Whitney U test indicated that this difference was statistically significant, Z = -5.6, $p < .001$. Cohen's effect size was large ($d = .81$). As displayed in Figure 10, within the current study women showed on average sustainability consciousness to a greater degree than men. Following the trend of the previous variables, further statistical tests using Kruskal-Wallis K indicated no statistically significant differences among other demographics.

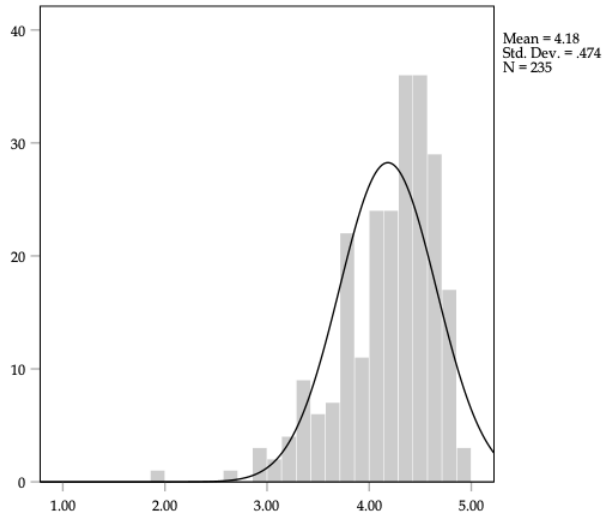

FIGURE 9 Distribution of sustainability consciousness

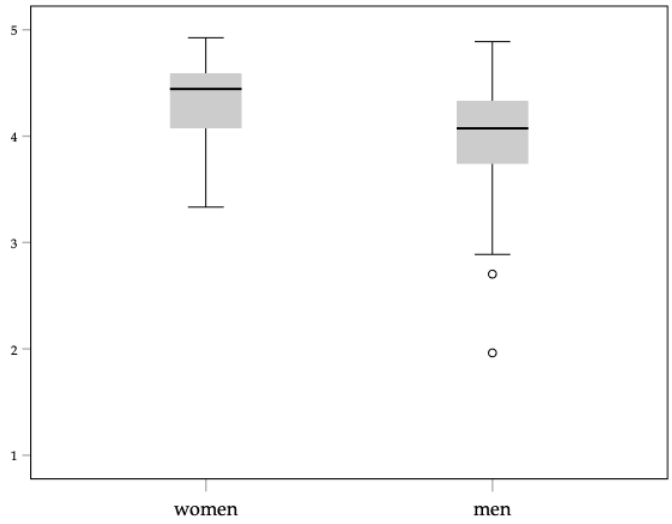

FIGURE 10 Gender-based medians of sustainability consciousness

In sum, the participants of the current study showed on average strong sustainability consciousness. This was evident also in the second level constructs of sustainability knowingness, behaviors and attitudes. That is, the participants seemed to have a good awareness of the theoretical components of sustainability. They seemed to have a positive attitude towards sustainability and to feel that it is important. They also seemed to perform actions in their everyday life that are contributing to sustainability. Gender had a large effect on participants' sustainability consciousness. That is, women were on average more conscious about sustainability than men. Also, gender had a medium effect on sustainability attitudes and behaviors. The effect gender had on sustainability knowingness was small. Finally, participants' age, type of residing municipality in Finland, educational level, life situation or used languages did not show differences in any of the variables.

Context and interlocutors relating to sustainability thoughts and discourse

In this section, participants were asked to elaborate on situations in which they have thought of sustainability on their own or discussed it, and with whom. Ten participants did not answer the open-ended question and were subsequently left out. The rest of the answers (*N*=225) were analysed by extracting and categorizing the stated contexts and interlocutors. The same participant could name several contexts and interlocutors. First, the answers were waded through in terms of the context where thinking and/or conversing about sustainability occurs. In total, 207 participants indicated one or more contexts in their answers (n=482). The results indicated that sustainability was often thought or conversed in the context of recycling (n=66), studies (n=58) and consumption habits and choices (n=57). Also, the context of food and diet (n=34) and everyday life (n=33) were often mentioned. All of the categories are presented in more detail in the Figure 11 below.

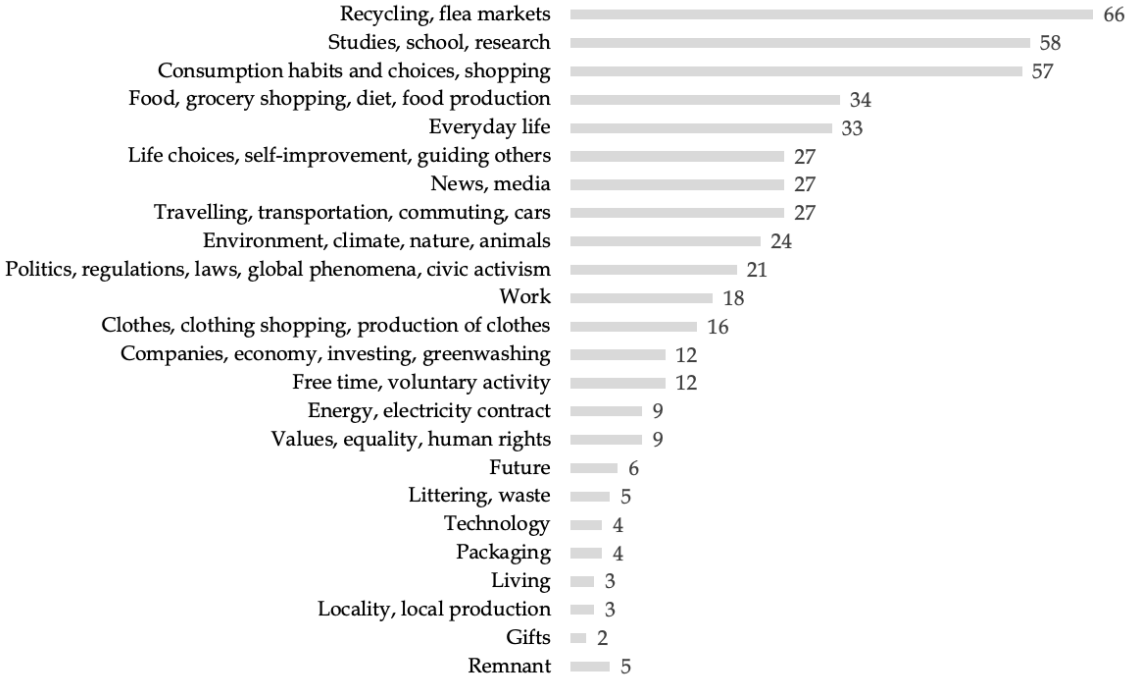

FIGURE 11 Context of thinking and/or conversing about sustainability (n=482)

Furthermore, a total of 140 participants indicated one or more interlocutors in their answers. The distribution of the interlocutors is presented in the Figure 12. The most common category rising from the answers was friends (n=106), followed by family members (n=89) and work colleagues (n=12). Moreover, the answers indicated that sustainability was conversed with acquaintances (n=6) and other people (n=6).

FIGURE 12 Mentions of interlocutors in sustainability conversations (n=140)

In sum, the participants of this study discussed about sustainability most often with friends and family members followed by conversations with work colleagues. The contexts where sustainability was thought, or it was the topic of the conversation were diverse. Recycling and studies were often indicated in contexts for sustainability thoughts or discourse. Also, a great deal of the mentions revolved around consumption habits and decisions as well as shopping. In addition, contexts relating to categories such as food and diet, everyday life, news and media, travelling and transport, environment, and politics were often mentioned in the participants' answers.

Notions of sustainability in relation to technology from before

At the end of the questionnaire, the participants were asked as to whether sustainability in relation to technology was something that they have thought of before. Fifteen answers that did not answer the question were removed from the analysis. The accepted open-ended answers (*N*=210) were organized into six categories in terms of whether the participant had previous notions of the inquired topic. The categories and frequencies are presented in Table 4 below. Of these participants, 51 % had thought about sustainability in relation to technology previously, whereas 29.1 % had not at all or hardly. Twenty percent of these participants could not say, or their answer did not indicate whether they had thought about the topic before. Of these, three participants indicated that they had not thought of the topic consciously but unconsciously.

TABLE 4 Notions of sustainability in relation to technology from before

Has the participant thought of sustainability in relation to technology before (*N*=210)	**n**	**%**
No	47	22.4
Not really / hardly	14	6.7
Not consciously, but unconsciously	3	1.4
Cannot say	8	3.8
Yes	107	51.0
The answer does not indicate	31	14.8

Thus, it can be said that a significant amount of the participants of this study had given thought to sustainability in relation to technology previously. However, there also were those who had not thought about the topic before at all. Interestingly, a small group of people indicated in their answer that they had thought about the topic unconsciously.

Free associations to the term "sustainable development" and to the terms "sustainable development" and "technology"

This section displays the results of the free association element in the questionnaire. In the first part, the participants were asked to write down the five first immediate associations that came to their mind from the term sustainable development. In the second part, they were asked to do the same, but this time the stimuli were the terms sustainable development and technology. The answers could be written in any language the participant found relevant. All answers obtained for both sustainable development (N=1165) and sustainable development and technology (N=1140) were carefully sieved through into seven categorial dimensions, respectively. Examples of associations coded into the dimensions are presented in Table 5. Given that the current study was interested in determining the saliency of the sustainability dimensions when the term is conjoined with technology, the dimensions obtained from previous studies were considered relevant. Moreover, the associations were assigned to dimensions

based on the encodings found from the previous studies discussed in chapter three (i.e., Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012) as well as the author's own judgement. This was done in the cases where the coding of previous studies could not be used to determine the dimension for a distinct association. In these cases, the association was assigned to the dimension that was seen to best enclose it. In addition, a remnant category for ambiguous answers was added.

TABLE 5 Sustainability dimensions with example associations

Dimension	**Examples of associations coded into dimension**
Environmental	'recycling', 'ecological', 'environment', 'nature', 'climate change', 'natural resources', 'nature conservation', 'green', 'renewable energy', 'solar energy', 'energy efficiency' 'carbon footprint'
Social	'responsibility', 'ethicality', 'fairness', 'cooperation', 'values', 'green values', 'politics', 'humanity', 'security'
Economic	'circular economy', 'economy', 'decreasing consumption', 'economic sustainability', 'corporate responsibility', 'resources'
Temporal	'future', 'change', 'continuity', 'durability', 'better future', 'securing future', 'well-being of future generations', 'renewal'
Developmental	'technology', 'green technology', 'clean technology', 'innovations', 'electric cars', 'solar panels', 'development', 'artificial intelligence', 'research', 'automatization', 'algorithm'
Confidence	'greenwashing', 'trend', 'doubt', 'challenging', 'high-quality', 'hope', 'good', 'opportunities', 'end of the world', 'greed', 'scary', 'planned obsolescence'
Compromise	'difficult', 'more expensive', 'price', 'incomplete', 'complicated', 'short usage age', 'requires know-how'
Remnant	'imagination', 'Africa', 'Asia', 'yellow', 'international major sports events', 'minimum', 'equilibrium', 'connection', 'cork'

When looking at the languages in which the associations were made, it was evident that the majority of them were made in Finnish. These were followed by associations made in English. Some of the associations were given as names, thus the language in which they were made was not detectable. In addition, other languages were used five times to describe an association. The Table 6 with details is presented below.

TABLE 6 Language of the terms used to describe associations

Language	**Associations with sustainable development (SD) and sustainable development and technology (SD+T)**									
	1. (%)		**2. (%)**		**3. (%)**		**4. (%)**		**5. (%)**	
	SD	**SD+T**	**SD**	**SD+T**	**SD**	**SD+T**	**SD**	**SD+T**	**SD**	**SD+T**

(continues)

Table 6 (continues)

Finnish	93.2	93.5	96.6	95.3	96.6	93.4	96.1	95.1	96.1	94.1
English	5.5	4.7	3.0	3.0	3.0	4.4	2.6	4.0	3.5	5.0
N/A	0.9	1.7	0.4	1.3	-	1.8	1.3	0.9	0.4	0.5
Other	0.4	-	-	0.4	0.4	0.4	-	-	-	0.5

The first part of the section investigated participants' associations to sustainable development when the term was presented alone. The answers obtained from this part were coded into categorical dimensions based on the previously established sustainability dimensions from literature. Forty-six percent of all of the associations related to the environmental dimension, 21 % to the social dimension, and 10.9 % to the temporal dimension. After this, 7.6 % of the associations were made to the economic dimension, 5.1 % to the dimension of confidence, 4.6 % to the developmental dimension, and finally 1.2 % to the dimension of compromise. Three and a half percent of the associations were coded into the remnant dimension. The dimensions and their total frequencies are presented in the Table 7 below.

TABLE 7 Dimensions associated with sustainable development

N=1165	**n**	%
Environmental	536	46.0
Social	245	21.0
Temporal	127	10.9
Economic	89	7.6
Confidence	59	5.1
Developmental	54	4.6
Remnant	41	3.5
Compromise	14	1.2

In order to see which dimension(s) is the most salient to the participants, the five first associations were analysed by observing the frequencies of the dimension in them. The frequencies of the dimensions in the five first associations are presented in the Table 8 below. The results showed evidence that the environmental dimension was dominant in all of the five associations. It was followed by the social dimension as the second most associated dimension. After this, the third most associated dimension was the temporal dimension, except for the fourth association, where the economic dimension was the third most salient. However, the difference was very small, making temporal association as salient in the fourth association as well.

TABLE 8 Frequencies of associations with sustainable development

Dimension	**Associations with sustainable development**									
	1. (n=235)		**2.** (n=234)		**3.** (n=235)		**4.** (n=231)		**5.** (n=230)	
	n	%	**n**	%	**n**	%	**n**	%	**n**	%
Environmental	140	59.6	116	49.6	105	44.7	94	40.7	81	35.2
Social	36	15.3	47	20.1	46	19.6	60	26.0	56	24.3
Economic	15	6.4	16	6.8	20	8.5	22	9.5	16	7.0
Temporal	25	10.6	28	12.0	28	11.9	21	9.1	25	10.9
Developmental	4	1.7	8	3.4	13	5.5	7	3.0	22	9.6
Confidence	10	4.3	11	4.7	11	4.7	13	5.6	14	6.1
Compromise	2	0.9	1	0.4	1	0.4	4	1.7	6	2.6
Remnant	3	1.3	7	3.0	11	4.7	10	4.3	10	4.3

Next, the reoccurrence of distinct associations was analysed for each of the five associations. In other words, the three most frequently mentioned words in each association section were observed (Table 9). The results showed that in all the five instances sustainable development was associated most often with *recycling* followed by *future*. However, the small n in each association's top three words indicated that the answers were greatly distributed in their specificity.

TABLE 9 Top three associations to sustainable development

Order	**Association with Finnish translation**	**n**	%
1. (n=235)	1. recycling *(kierrätys, kierrättäminen)* 2. sustainability *(ekologisuus)* 3. environment *(ympäristö)*	27 23 13	11.5 9.8 5.5
2. (n=234)	1. recycling *(kierrätys, kierrättäminen*) 2. future *(tulevaisuus)* 3. sustainability *(ekologisuus)* 3. natural resources *(luonnonvarat)* 3. environment *(ympäristö)*	13 9 8 8 8	5.6 3.8 3.4 3.4 3.4
3. (n=235)	1. recycling *(kierrätys, kierrättäminen)* 2. green (*vihreä)* 3. environment *(ympäristö)* 3. future *(tulevaisuus)*	13 8 7 7	5.5 3.4 3.0 3.0
4. (n=231)	1. recycling *(kierrätys)* 2. future *(tulevaisuus)* 3. climate change *(ilmastonmuutos)*	8 7 6	3.5 3.0 2.6
5. (n=230)	1. recycling *(kierrätys, kierrättäminen)* 1. future *(tulevaisuus)* 2. climate change *(ilmastonmuutos)* 3. greenwashing *(viherpesu)*	8 8 7 4	3.5 3.5 3.0 1.7

In sum, the most salient dimensions found from participants' associations were environmental, social, and temporal dimensions. This was further evident when the associations were observed in the order of appearance from first to fifth, where the same dimensions appeared most popular. Observing the associations' order further informed that the most common distinct association was made to *recycling* that appeared as the most popular word from first to fifth association. Also, the word *future* was detected in all of the associations from second to fifth association. The environmental dimension was the most prominent throughout the analysis. That is, based on the analysis of free associations, the participants of this study seemed to grasp sustainability mainly through environmental aspects followed by social aspects and aspects relating to time and longevity. Distinct associations appeared to relate strongly to environmental aspects and specifically to recycling and the future.

The same procedure was conducted with the second part of the association section where participants were asked to write down the first five immediate associations with sustainable development and technology. Over a third of the associations (33.8 %) related to the environmental dimension, 27.5 % to the developmental dimension, and 13 % to the social dimension. Furthermore, 11.1 % of the associations were made to the dimension of confidence, 7.5 % to the temporal dimension, and 4.6 % to the economic dimension. Finally, the dimension of compromise consisted of 1.1 % of the associations, whereas 1.6 % of the associations were coded into the remnant dimension. Accordingly, the dimensions and their total frequencies are presented in the following Table 10.

TABLE 10 Dimensions associated with sustainable development and technology

N=1140	**n**	%
Environmental	385	33.8
Developmental	313	27.5
Social	148	13.0
Confidence	126	11.1
Temporal	85	7.5
Economic	53	4.6
Remnant	18	1.6
Compromise	12	1.1

In a similar manner, the analysis of the associations with sustainable development and technology followed the aforementioned procedure. The frequencies of the dimensions in the five first associations are presented in the Table 11 below. Similar to the associations made for sustainable development alone, the results indicated that the environmental dimension was the most salient in all of the five associations. Here however, it was closely followed by the developmental dimension. The third most salient dimension was the social dimension, except in the first association where the dimension of confidence was more sali-

ent. This followed also in the third association where the difference between the social dimension and dimension of confidence was very small.

TABLE 11 Frequencies of associations with sustainable development and technology

Dimension	**Associations with sustainable development and technology**									
	1. (n=232)		**2.** (n=232)		**3.** (n=228)		**4.** (n=226)		**5.** (n=222)	
	n	%	**n**	%	**n**	%	**n**	%	**n**	%
Environmental	91	39.2	81	34.9	81	35.5	65	28.8	67	30.2
Social	11	4.7	31	13.4	27	11.8	42	18.6	37	16.7
Economic	11	4.7	9	3.9	9	3.9	12	5.3	12	5.4
Temporal	17	7.3	11	4.7	21	9.2	13	5.8	23	10.4
Developmental	74	31.9	75	32.3	56	24.6	56	24.8	52	23.4
Confidence	22	9.5	23	9.9	26	11.4	30	13.3	25	11.3
Compromise	2	0.9	1	0.4	3	1.3	4	1.8	2	0.9
Remnant	4	1.7	1	0.4	5	2.2	4	1.8	4	1.8

Next, the three most frequently mentioned words in each association section were also observed. Not as many associations were written down for this part as in the previous. The results, specifically the small n, showed that the associations were even more distributed in this section than the previous one. *Recycling* and *future* were popular associations here as well together with *electric cars* and *innovations*. Also, associations dealt with matters of energy more often in this section. The translated top words or associations for each five associations are presented in the Table 12 below.

TABLE 12 Top three associations to sustainable development and technology

Order	**Association with Finnish translation**	**n**	%
1. (n=232)	1. electric cars *(sähköautot)* 1. recycling *(kierrätys*) 1. innovations *(innovaatiot)* 2. sustainability *(ekoklogisuus*) 3. future *(tulevaisuus)*	7 7 7 6 5	3.0 3.0 3.0 2.6 2.2
2. (n=232)	1. electric cars *(sähköautot)* 2. recycling *(kierrätys, kierrättäminen)* 2. renewable energy *(uusiutuva energia)* 3. innovations *(innovaatiot)*	6 5 5 4	2.6 2.2 2.2 1.7
3. (n=228)	1. recycling *(kierrätys*) 2. future *(tulevaisuus)* 3. solar energy *(aurinkoenergia)*	6 5 4	2.6 2.2 1.8
4. (n=226)	1. recycling *(kierrätys, kierrättäminen)*	7	3.1

(continues)

Table 12 (continues)

	1. innovations *(innovaatiot)* 2. future *(tulevaisuus)* 3. electric cars *(sähköautot)* 3. circular economy *(kiertotalous)* 3. solar panels *(aurinkopaneelit)*	7 4 3 3 3	3.1 1.8 1.3 1.3 1.3
5. (n=222)	1. future *(tulevaisuus)* 2. energy efficiency *(energiatehokkuus)* 3. recycling *(kierrätys)*	7 6 4	3.2 2.7 1.8

In sum, the most salient dimensions found from participants' associations towards sustainable development and technology were environmental, developmental, and social dimensions. Here however, the distribution between the environmental and other dimensions was not as distinct as in the previous part, but the developmental dimension was almost as salient. Observing the associations in order of appearance from first to fifth showed that the same dimensions appeared the most popular. However, also the dimension of confidence was more relevant in this section than in the previous one. Looking at the association order further informed that the distinct associations to *electric cars*, *innovations* and matters relating to energy appeared popular here. In addition, the associations made to *recycling* and *future* were present also in this section. In this section the prominence of the environmental dimension was not as great as in the previous part.

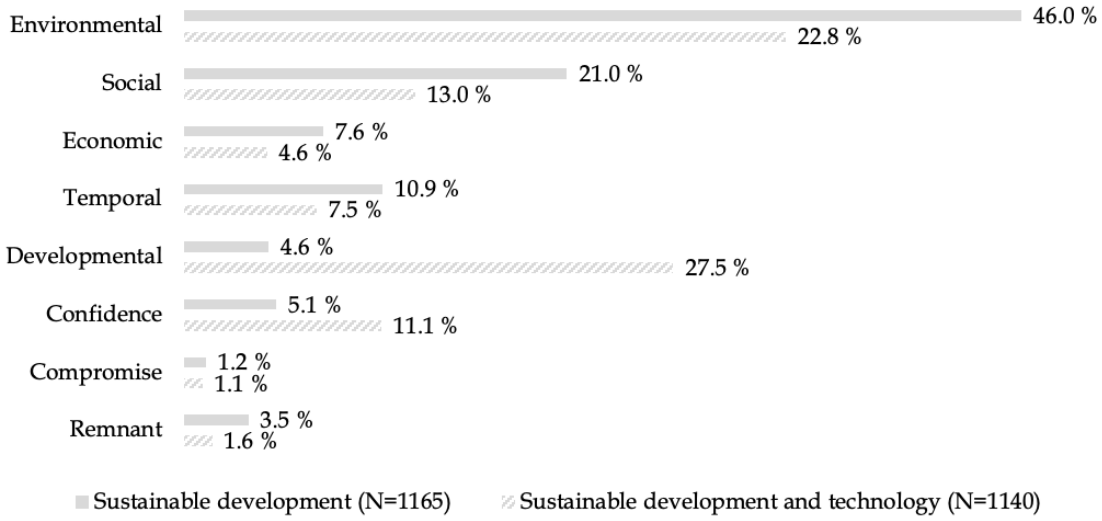

FIGURE 13 Comparison of the distribution of associated dimensions

Finally, summarizing the current section, the distribution of the dimensions in both association cases is presented in Figure 13. Here the strong presence of the environmental dimension regardless of the stimulus is detectable. Looking at other dimensions, it can be seen that while sustainable development alone is often associated with social, temporal, and economic dimensions, sustainable development in relation to technology appears to be associated with develop-

mental and social dimensions, as well as with the dimension of confidence. Thus, the saliency of dimensions associated with sustainability seem to vary depending on the context except for the environmental dimension that can be seen to be the most salient in both cases.

Context of technology where the term "sustainability" last encountered

In this section the participants were also inquired regarding the last occasion where they had encountered the term sustainability in relation to technology. Eight participants who did not answer the question were excluded from the analysis. Again, the rest of the answers (N=227) to the open-ended question were thoroughly observed and transferred into four categories. From the answers, it was possible to extract that 3.5 % had not encountered the term in relation to technology, 20.3 % did not remember or could not say, 5.3 % were not sure, and 70.9 % gave an answer of having encountered the term at some point in the recent past. The term was most often encountered in the context of commercials or as a property or function of a technological product. The frequencies are presented in the Table 13 below.

TABLE 13 Encounter of the term sustainability in technology's context

Has the participant encountered the term sustainability in technology's context before (*N*=227)	**n**	%
No	8	3.5
Does not remember / cannot say	46	20.3
Probably	12	5.3
Yes	161	70.9

The answers that indicated that the participant had encountered the term were further analysed. One hundred and seven participants indicated a more specific context for the encounter in terms of technology. These instances were grouped into seven categories. The term *sustainability* was most often encountered in the context of electronic devices (n=28), followed by energy sources (n=24), cars (n=23), specific technologies (n=18), data and artificial intelligence (n=10), and materials and technical parts (n=8). Five answers were categorized into a remnant category. Furthermore, these encounters happened often in the contexts of social media, commercials and news, reading non-scientific and scientific articles, at university courses or other educational settings, in a work-related context, or at an event.

Importance of sustainability attributes for currently used technology

This section asked participants to think of their technology use and rank seven respective sets with four statements each into an order of importance from most important to fourth important on a scale of 1 to 4 (*1 = Most important, 2 = Second most important, 3 = Third most important, 4 = Fourth most important*). The sets rep-

resenting sustainability dimensions and their statements were based on the literature discussed in chapter three. All the answers were analysed (*N*=235).

The distribution of the answers from the first set relating to attributes of the environmental dimension indicated that the most important attribute for technology was that it does not jeopardize the environment. In particular, 54 % of the participants found this the most important attribute from the given set. Producing waste was selected as the fourth most important attribute for technology 47.2 % of the participants. The most and second most important attributes were clearly represented in the results, yet, the third and fourth attribute seemed to share a similar level of importance. The distribution of the frequencies and the medians is presented in more detail in the Table 14 below.

TABLE 14 Ranked attributes of the environmental dimension

***N*=235**	**1**	**2**	**3**	**4**	**median**
8.1. The technology that I use does not jeopardize the environment.	127 54.0 %	56 23.8 %	38 16.2 %	14 6.0 %	1.00
8.2. It is possible to recycle the technology that I use.	48 20.4 %	91 38.7 %	58 24.7 %	38 16.2 %	2.00
8.3. The production of the technology that I use uses renewable resources.	41 17.4 %	44 18.7 %	78 33.2 %	72 30.6 %	3.00
8.4. The technology that I use does not produce waste.	19 8.1 %	44 18.7 %	61 26.0 %	111 47.2 %	3.00

The distribution of the answers from the second set relating to attributes of the social dimension suggested that the most important attribute of technology is that it is produced ethically. Fifty-seven point four percent of the participants evaluated as the most important attribute while the attribute of creating opportunities for all people was evaluated as fourth most important by 31.1 % of the participants. However, the observed medians indicated an unclear order of importance for all but the most important attribute. The frequencies and the medians are presented in more detail in the Table 15 below.

TABLE 15 Ranked attributes of the social dimension

***N*=235**	**1**	**2**	**3**	**4**	**median**
10.1. The technology that I use advances equality among people.	19 8.1 %	70 29.8 %	80 34.0 %	66 28.1 %	3.00
10.2. The technology that I use is produced ethically.	135 57.4 %	36 15.3 %	38 16.2 %	26 11.1 %	1.00
10.3. The technology that I use creates opportunities for all people.	55 23.4 %	52 22.1 %	55 23.4 %	73 31.1 %	3.00
10.4. The technology that I use advances human dignity.	26 11.1 %	77 32.8 %	62 26.4 %	70 29.8 %	3.00

The third set related to attributes of the economic dimension. Here, the most important attribute selected by 64.7 % of the participants was that companies manufacturing technology act responsibly towards their stakeholders. Technology being profitable for companies was evaluated as the fourth most important attribute by 68.1 % of the participants. In addition, the distribution of medians indicated a clear order of importance. The frequencies and the medians are presented in more detail in the Table 16 below.

TABLE 16 Ranked attributes of the economic dimension

N=235	1	2	3	4	median
12.1. The technology that I use is profitable for companies.	14 6.0 %	20 8.5 %	41 17.4 %	160 68.1 %	4.00
12.2. The technology that I use inspires and produces new business ideas.	31 13.2 %	44 18.7 %	120 51.1 %	40 17.0 %	3.00
12.3. The technology that I use creates new jobs decreasing unemployment in the world.	38 16.2 %	131 55.7 %	47 20.0 %	19 8.1 %	2.00
12.4. The companies that manufacture the technology that I use act responsibly towards their employees, clients, and suppliers.	152 64.7 %	40 17.0 %	27 11.5 %	16 6.8 %	1.00

The fourth set related to attributes of the temporal dimension. Sixty-six point four percent of the participants evaluated technology's endurance in use over the years as the most important attribute. Technology maintaining its value over the years was considered the fourth most important attribute by 52.8 % of the participants. Here, similar to the previous set, the observed medians indicated a clear order of importance for all the attributes. The distribution of the frequencies and the medians is presented in more detail in the following Table 17 below.

TABLE 17 Ranked attributes of the temporal dimension

N=235	1	2	3	4	median
14.1. The technology that I use endures years of consumption and use.	156 66.4 %	62 26.4 %	14 6.0 %	3 1.3 %	1.00
14.2. The technology that I use responds already today to the needs of future.	20 8.5 %	76 32.3 %	81 34.5 %	58 24.7 %	3.00
14.3. After years, the technology that I use is still valued.	2 0.9 %	29 12.3 %	80 34.0 %	124 52.8 %	4.00
14.4. The technology that I use does not jeopardize the quality of life of the future generations.	57 24.3 %	68 28.9 %	60 25.5 %	50 21.3 %	2.00

The distribution of the answers from the fifth set relating to attributes of the developmental dimension indicated that 57 % of the participants evaluated the holistic rather than task-specific nature of technology as the most important attribute. Forty-five point one percent of the participants indicated the attribute of technology utilizing the newest innovations as the fourth most important attribute. However, the observed medians indicated an unclear order of importance for all but the most and second most important attribute. The distribution of the frequencies and the medians is presented in more detail in the Table 18 below.

TABLE 18 Ranked attributes of the developmental dimension

N=235	1	2	3	4	median
16.1. The technology that I use is based on scientific research.	50 21.3 %	51 21.7 %	69 29.7 %	65 27.7 %	3.00
16.2. The technology that I use utilizes the newest innovations.	22 9.4 %	33 14.0 %	74 31.5 %	106 45.1 %	3.00
16.3. The technology that I use adapts to the different needs of people all over the world.	29 12.3 %	94 40.0 %	64 27.2 %	48 20.4 %	2.00
16.4. The technology that I use does not serve only one purpose but can be used holistically for several purposes.	134 57.0 %	57 24.3 %	28 11.9 %	16 6.8 %	1.00

The sixth set related to the attributes of the dimension of confidence. The trust that technology works in different situations was considered as the most important attribute by 48.5 % of the participants. The fourth most important attribute evaluated by 54 % of the participants was that it is not possible to scam people with the used technology. Notwithstanding, the observed medians indicated an unclear order of importance for all but the third and fourth most important attribute. Thus, the most important attribute could not be extracted. The distribution of the frequencies and the medians is presented in more detail in the Table 19 below.

TABLE 19 Ranked attributes of the dimension of confidence

N=235	1	2	3	4	median
18.1. It is not possible to scam people with the technology that I use.	24 10.2 %	33 14.0 %	51 21.7 %	127 54.0 %	4.00
18.2. I can trust, that the technology that I use works in different situations.	114 48.5 %	60 25.5 %	38 16.2 %	23 9.8 %	2.00
18.3. The technology that I use has the potential to make a positive impact on people's lives.	56 23.8 %	50 21.3 %	84 35.7 %	45 19.1 %	3.00
18.4. The technology that I use is easily understandable and usable.	41 17.4 %	92 39.1 %	62 26.4 %	40 17.0 %	2.00

Finally, the distribution of the answers in the seventh set relating to the attributes of the dimension of compromise suggested that 46.4 % of the participants evaluated technical performance of technology as the most important attribute. Here, the fourth most important attribute was the requirement of learning new skills in order to use technology as evaluated by 49.8 % of the participants. Similar to the previous set, the observed medians indicated an unclear order of importance for all the attributes. Thus, also here the most important attribute could not be extracted. The distribution of the frequencies and the medians is presented in more detail in the Table 20 below.

TABLE 20 Ranked attributes of the dimension of compromise

***N*=235**	**1**	**2**	**3**	**4**	**median**
20.1. The costs of the technology that I use are the same regardless of the person using it.	64 27.2 %	87 37.0 %	54 23.0 %	30 12.8 %	2.00
20.2. The technical performance of the technology that I use is high.	109 46.4 %	53 22.6 %	48 20.4 %	25 10.6 %	2.00
20.3. The technology that I use does not require learning new skills in order to use it.	26 11.1 %	43 18.3 %	49 20.9 %	117 49.8 %	3.00
20.4. The technology that I use is equally available to all the people in the world.	36 15.3 %	52 22.1 %	84 35.7 %	63 26.8 %	3.00

For the final analysis, the most important attributes of each section were chosen based on a median of 1 indicating a more representative position as the most important attribute among the participants than mere frequencies. Accordingly, given the indecisiveness of the importance of the attributes, the sets of confidence and compromise were not included in the analysis. Therefore, the most important sustainability attributes ranked by the participants were: technology endures years of consumption and use, its manufacturers act responsibly towards their stakeholders, it is produced ethically, it serves more than one purpose and can be used holistically, and it does not jeopardize the environment. The most important attributes are collected to the Table 21 below.

TABLE 21 Most important sustainability attributes for technology

Most important sustainability attributes for technology	
MI1_T	The technology that I use endures years of consumption and use.
MI2_EC	The companies that manufacture the technology that I use act responsibly towards their employees, clients, and suppliers.
MI3_S	The technology that I use is produced ethically.
MI4_D	The technology that I use does not serve only one purpose but can be used holistically for several purposes.
MI5_EN	The technology that I use does not jeopardize the environment.

Statistical tests were further implemented to explore the attributes. It was discovered that women (*Mdn* = 1.00) evaluated the importance of three out five attributes different than men (*Mdn* = 2.00). Specifically, a Mann-Whitney U test demonstrated that this difference was statistically significant for the attributes of MI2_EC with the results Z = 5.2, $p < .001$, $d = .11$, MI3_S with the results Z = 3.1, $p = .002$, $d = .63$, and MI4_D with the results Z = 2.7, $p = .007$, $d = .38$. Thus, the results suggested that on average women and men did not evaluate the importance of these three attributes similarly. That is, women evaluated on average the responsibility of companies manufacturing technology towards its stakeholders, ethical production of technology, and holistic use of technology more important than men. However, the effect sizes were small, except for MI3_S where the effect size was medium. Thus, the results suggested that only the importance of technology's longevity and that technology does not jeopardize environment were ranked on average similarly by both women and men. Further tests indicated no evidence of difference between age group, education, life situation, or used languages.

Finally, the most important sustainability attributes were tested against participants' sustainability consciousness. Kruskal-Wallis H indicated statistically significant differences between sustainability consciousness and the four attributes of MI2_EC with the test result H(3) = 35.5, $p < .001$, $d = .81$, MI3_S with the result with the test result H(3) = 19.9, $p < .001$, $d = .56$, and MI4_D with the test result H(3) = 8.9, $p = .030$, $d = .32$. The further results of Dunn-Bonferroni pairwise test for MI2_EC indicated evidence of a difference between medium (*Mdn* = 2.00) and very high (*Mdn* = 1.00) ($p < .001$) as well medium and high (*Mdn* = 1.00) ($p = .001$) sustainability consciousness, and for MI3_S between medium (*Mdn* = 3.00) and very high (*Mdn* = 1.00) ($p < .001$) as well medium and high (*Mdn* = 1.00) ($p = .019$) sustainability consciousness. For MI4_D Dunn-Bonferroni pairwise test did not show evidence of difference between any of the groups. In sum, the results indicated that participants with very high or high sustainability consciousness were more likely to evaluate the responsibility of companies manufacturing technology towards its stakeholders and ethical production of technology as the most important compared to those with medium sustainability consciousness.

Importance of sustainability for technology

This section sought to observe whether sustainability is perceived as important for technology and its development. The distribution of the sum variable displayed in Figure 14 shows that participants evaluated the importance of sustainability for technology as high (*Mdn* = 4.10). Furthermore, women (*Mdn* = 4.20) evaluated this importance higher than men (*Mdn* = 4.00). A Mann-Whitney U test indicated that this difference was statistically significant, Z = -3.4, $p = .001$, $d = .46$. That is, women considered on average sustainability more important for technology than men. The effect size was small. The medians of the genders are pictured in Figure 15. Further groupwise tests using Kruskal-Wallis K indicated no statistically significant differences among other demographics.

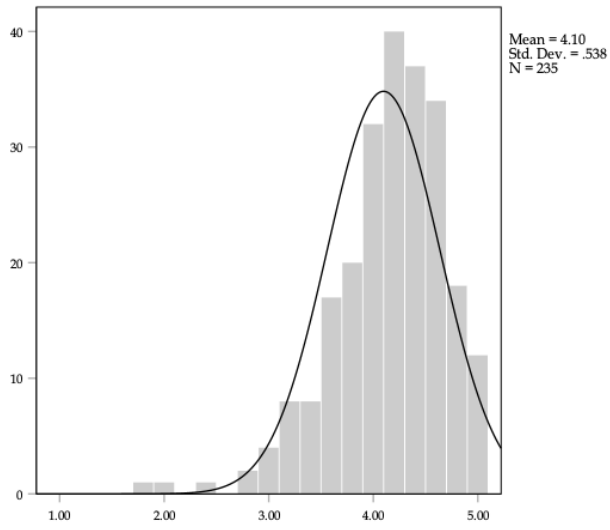

FIGURE 14 Distribution of importance of sustainability to technology

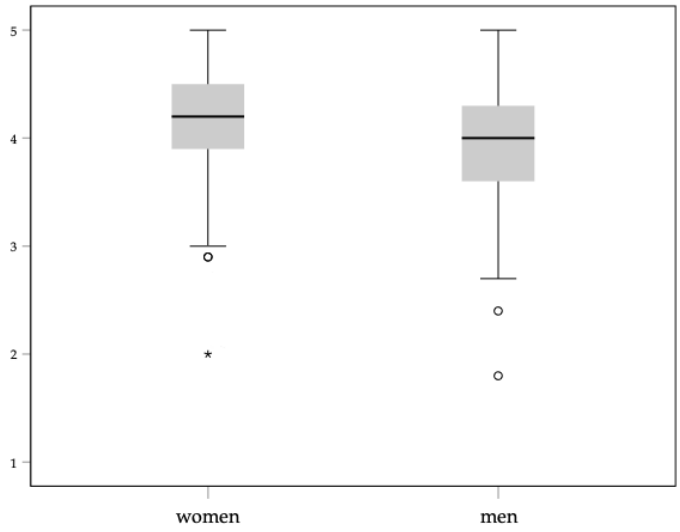

FIGURE 15 Gender-based medians of importance of sustainability for technology

Next, the correlation between the importance of sustainability for technology and sustainability consciousness was investigated. A positive correlation was assumed, that is, a stronger sustainability consciousness was thought to result in a stronger sense of importance of sustainability for technology. The statistical test was implemented with Spearman's correlation test and it provided the result $\rho = .65$, $p < .001$. The results showed evidence of a positive correlation with a moderate to strong strength. The correlation of the variables is pictured in Figure 16. A further regression analysis was implemented to investigate whether further factors affect importance of sustainability for technology. The explanatory factors chosen for the model were gender, age, type of residing municipality, education, life situation, and sustainability consciousness. However, out of

the variables only sustainability consciousness showed strong explicatory significance to the importance of sustainability in technology underlining the already found correlation. In sum, the results indicated that as sustainability consciousness increases so does the sense of importance of sustainability in technology.

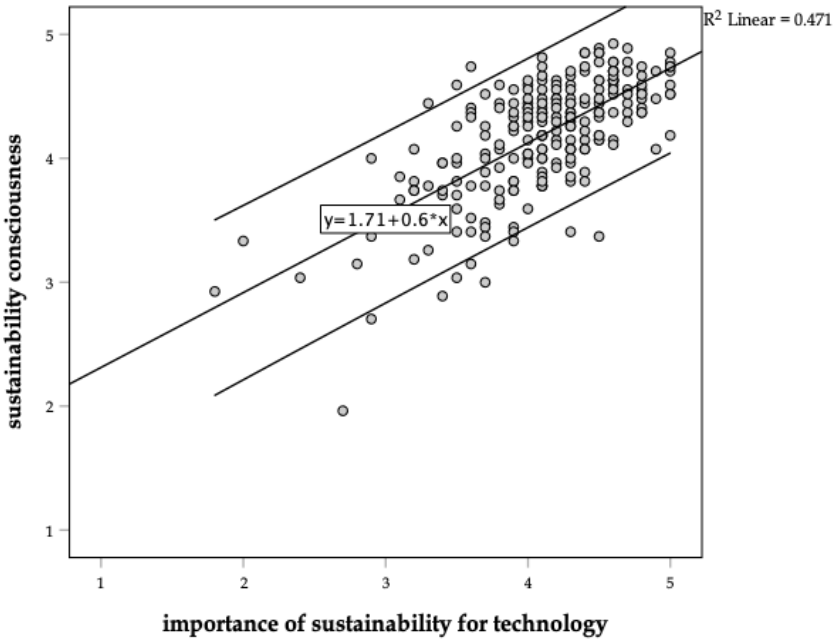

FIGURE 16 Correlation of sustainability consciousness and importance of sustainability for technology

5.3 Reliability and Validity

Finally, the design and implementation of the study as well as the obtained results are evaluated and possible implications for results and their application are clarified in terms of reliability and validity (Vilkka, 2007). First, the reliability of the conducted study is taken under scrutiny. It can be said that reliability to refer to the assessment of reproducibility of a given study in terms of measurements and the phenomena being investigated (Metsämuuronen, 2011). In other words, if the study would be conducted again, how similar would the results be? In reliability, the aspects relating to measurement and random errors are especially under scrutiny (Vilkka, 2007). In the current study, the examined phenomena were measured with an online survey which can be considered to be reliable and easy to replicate. It can also be deemed suitable for the objective of collecting a large amount of quantitative data. However, in the current study the amount of data that was obtained remained relatively small, which in turn may be a signifier of low reliability. Finally, the sum variables initially constructed for analysis received low reliability rates signifying that they cannot be

considered entirely reliable. Thus, the overall reliability of the current study can be considered problematic.

Validity refers to the ability of the chosen measure or study method to truly measure that what is wanted to be measured (Vilkka, 2007). In the current study, validity is observed from the standpoints of external and internal validity. While external validity evaluates the generalization of a given study and its results, internal validity assesses the credibility of it in regard to concepts and theory (Metsämuuronen, 2011). That is, whether the chosen concepts align with theory, whether they are operationalized accordingly and whether they attend to the phenomena being investigated extensively enough (Metsämuuronen, 2011). Looking first at the factors affecting external validity of the current study, that is the generalization of it and its results, it can be considered that the sampling is not completely representative in terms of the demographics of the participants. In other words, the demographics were skewed in that the majority of the participants represented young Finnish speaking students aged 18-34 living in a middle-sized major city in Finland. Therefore, if applicable, the generalization may only be possible within this demographic group. Thus, the external validity of the current study can be deemed low.

In a similar manner, the internal validity, that is the conceptual and theoretical credibility of the current study, can be considered problematic. Vilkka (2007) suggests that in order to investigate the validity of a study the operationalization of the concepts to everyday language, the formulation of questions and answer options in the questionnaire, the functionality of the chosen measurement scales, and the possible inaccuracies in the measures should be evaluated. In the current study, only a single section of the questions came from a previously validated questionnaire, whereas the rest of the questionnaire was not empirically validated. That is, the questions and answer options were selected and designed based on the selected literature further affecting the construction of sum variables in the data analysis. Thus, the operationalization of the concepts cannot be said to be completely valid. Also, in terms of distinct methods used in the questionnaire, the use of ranking has been proven problematic in terms of validity (e.g., Fabbris, 2013). Additionally, some of the questions and answer options in the questionnaire were only after its release detected to have grammatical errors which consequently may have influenced how participants answered them. Furthermore, the translation of the questionnaire questions and answer options from English to Finnish may have resulted in somewhat ambiguous questions further lowering the reliability of the current study. Specifically, this ambiguity was brought forward in the questionnaire feedback where some participants indicated that answering the questionnaire had been difficult because of the complex formatting of the questions and the lack of definition of the main concepts being inquired about. In a more general sense, it should also be noted that because of the isolated nature of an online questionnaire, some of the questions of the current study may have been misinterpreted or the answers given to them may not have been honestly issued. Also, when a phenomenon is investigated via predetermined answers as in the ranking section of the questionnaire of the current study, predetermined results are inevitably obtained as participants are not offered an option for an alterna-

tive answer. In short, although a pilot study was conducted before the release of the questionnaire, some structural issues and issues concerning content remained which had negative implications to the internal validity of the current study.

6 DISCUSSION

Before final conclusion, this chapter discusses the results obtained and presented in the previous chapter. The aim of this thesis was to empirically investigate how people make sense of the concept of sustainability when it is conjoined with technology. In addition, it aimed to investigate whether sustainability is perceived as important for technology. These aims were approached in seven sections. First, participants' sustainability consciousness was evaluated through three sublevels of sustainability knowingness, attitudes and behaviors. This was followed by the analysis of two of the open-ended questions relating to context and interlocutors of sustainability thoughts and discourse, and whether participants had notions of sustainability in relation to technology previously. Fourth, the free associations that the participants had about the term sustainable development and sustainable development and technology were inspected. In particular, the saliency of seven sustainability dimensions was investigated. After this, the final open-ended question was analysed to find out whether and in which technological context participants have encountered the sustainability term before. These five sections provide an answer to the first investigation aim. Moving on, the sixth and seventh stages looked into which sustainability attributes were evaluated most important for technology and whether sustainability is perceived as important for technology. Here, sustainability consciousness' role in relation to importance was also investigated. Thus, these two final sections provided an answer to the second investigation aim. Next, the sections are discussed in more detail regarding the study aims.

How is sustainability understood in the context of technology?

First, the results indicate that the experience and awareness of sustainability – that is sustainability consciousness – of the participants of the current study was strong. Also, when investigating the subconstructs of sustainability consciousness their sustainability knowingness, attitudes and self-reported behaviors were strong. Gericke et al. (2019) suggest that the sustainability consciousness questionnaire can be used in several contexts to investigate the way of thinking in relation to sustainability among a population. For instance, previous

studies have investigated sustainability consciousness in relation to cultural differences (e.g., Berglund et al., 2019). Therefore, possible differences among demographic groups were also of interest within this study. Similar to the findings of Berglund et al. (2019), here too sustainability consciousness and its subconstructs showed a gender-related difference in that women showed a general pattern of higher medians than men. In particular, women had more positive attitudes towards sustainability, and they were more likely to undertake actions contributing to sustainability than men. As is, their sustainability consciousness was stronger than of men. However, other demographics such as age, education or location of residence did not show evidence of difference. The strong sustainability consciousness could be due to the increased attention sustainability has received in the past years in various aspects of life. This is something that was also evident in the participants' answers to the context of where and with whom sustainability is discussed and thought of. Here, the contexts varied greatly and touched upon the aspects of everyday life extensively. Also, sustainability was discussed in different social groups. Therefore, it could be concluded that matters relating to sustainability are often present in the participants' lives and therefore may contribute to their sustainability consciousness.

Looking at the context and interlocutors relating to sustainability thoughts and discourse more closely, the results from the second open-ended question showed that among those participants that provided an answer to this question discussions about sustainability most often took place among friends, family members and work colleagues. Furthermore, the contexts where sustainability was thought or discussed varied greatly from recycling to study settings and to consumption habits. Accordingly, for the participants of this study, various social contexts were at play in sustainability discourse. Reflecting on Wittgenstein's (1953) thesis, as people participate in distinct social situations, they participate in a particular language game shaping the language and meaning within that context. Therefore, it could be argued that the meaning of sustainability is dynamically taking shape within and across the communication instances within these contexts. Furthermore, the position sustainability holds in the contemporary Finnish culture seems to be multidimensional touching upon various aspects in the everyday lives of people.

The results from the third open-ended question showed that a great deal of the participants of the current study had given thought to sustainability in relation to technology on some level, while there were also some who had not. Sustainability initiatives relating especially to environmental issues are increasingly part of the strategies of major technology companies such as Apple (2020) and Google (Pichai, 2020), which therefore end up being communicated to the general public who also uses these products. Furthermore, electric cars and renewable sources of energy have for a while now been part of the reality in the Global North. Therefore, it is interesting that some of the participants of the current study stated that they had not thought of sustainability and technology in unison. This could mean that sustainability as such does not explicitly come through in contexts of technology, even it would be an implicit part of its design. Furthermore, three participants of the current study indicated that they had not thought of sustainability in relation to technology consciously but un-

consciously. This is interesting not only because of their own knowledge of this unconscious action, but also because it shows how sustainability has taken a somewhat tacit place in the technology arena.

Next, the results of the free associations to sustainability and sustainability and technology are discussed, starting with the associations made to sustainability alone. The participants of this thesis associated sustainability most strongly with the environmental, social, and temporal dimensions. This was evident in their first and immediate associations as well as in the association instances that followed. The most dominant dimension throughout the analysis was the environmental dimension. This finding aligns with the results of previous studies that also found that people rely on the environmental dimension to make sense of sustainability (Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012). Similar to the findings of Simpson and Radford (2012), also in the current study the dimension relating to time and longetivity was salient. Additionally, the social dimension was more salient here than in the previous studies. In contrast to Hanss and Böhm's (2012) results, the developmental dimension was not very salient in participants' associations to sustainability within this study. However, all of the investigated dimensions were present in the participants' answers. Looking at distinct associations made to sustainability, the word *recycling* was most often associated with the concept. Also, there were several associations to the word *future*. The associations made to the social dimension did not show a pattern of popularity but were varied in their content.

The results from associations made to sustainability and technology indicated showed further evidence of the rule of the environmental dimension in people's perceptions. In particular, sustainability and technology were associated most strongly with the environmental, developmental, and social dimensions. Even though the environmental dimension was the most salient, the differences between the saliencies of the other dimensions were not as great as when sustainability was associated alone. That is, environmental and developmental dimensions were almost equally salient in the association made to sustainability and technology. The saliency of developmental dimension was expected as its coding included topics relating to technology, research, and innovations. Interestingly, the dimension of confidence was more salient than when sustainability was inquired alone. Therefore, it could be that when sustainability is thought in relation to technology it raises both a negative and positive sense of confidence towards it. That is, in technological context, sustainability was considered both promising and as providing opportunities, but also a lot of scepticism was appointed to it. Distinct associations to this section showed that sustainability and technology were often associated with *electric cars*, *innovations* and with matters relating to energy, but also to *recycling* and *future* as in the previous part. As it was discussed in the chapters before, technology designers have not as of yet found a unified front when it comes to attending to sustainability challenges (Knowles et al., 2018). The plurality of aspects relating to sustainability in the context of technology is also evident here as it seems that the participants consider the concept holistically and they seem to assign several distinct associations to it. Therefore, in lieu of looking for some kind of all-purpose mould for sustainability, it could be asked whether sustainability

would actually benefit from a wider acknowledgement and acceptance of its multifariousness. This would, arguably, allow people to focus on the sections of sustainability that are relevant to them in comparison to focusing on nothing at all when these fall outside the issued definition.

Finally, the results of the first open-ended question interested in the exposure to the sustainability term particularly indicated that the majority of the participants had encountered the term sustainability in some context relating to technology before. The term was often encountered in relation to electronic devices, energy sources and cars, and happened in the context of social media, commercial and news, and in educational or work settings and at events. Thus, the term sustainability appears to be present also in a wide range of technological initiatives, thus connecting the domains.

Attempting to summarize the results obtained from the described sections with the intention to shed light on the first study aim, the results showed evidence that the participants of the current study were highly aware of the sustainability concept and seemed to understand it holistically. A great number of the participants indicated thinking about sustainability and/or conversing about it in different contexts with a variety of people. Many of them had encountered the term before in some context relating to technology and had thought about sustainability in relation to technology. However, their understanding was skewed in favour of the environmental dimension of sustainability in both association cases. Thus, mirroring Putnam's (1975) theory of linguistic labour, it appeared that sustainability to enjoys a role as a concept that can be successfully used in interaction situations even if the "original" meaning is not truly known. In particular, the results showed that sustainability was understood firstly via the environmental dimension when connected with technology as well. Relating to this, recycling in general but also in terms of electronic waste has increased in the past year in Finland (Lukkari, 2021). This could explain the several mentions it received throughout the questionnaire answers as it may have been more present in the everyday lives of people. As Waas et al. (2011) point out, societal and normative choices that come to be through values that are culturally and temporally shaped are always implied in sustainability. Thus, it may be that sustainability is highly valued in the prevailing Finnish culture given that the results indicate it holds a great importance to the participants of the current study. That is, in Finland it seems that the societal and normative choices are pro sustainability all the way to the context of technology.

Is sustainability perceived as important for technology?

Next, the two sections relating to the second investigation aim are discussed starting with the results from the sixth section. Accordingly, the participants of the current study ranked on average the following sustainability attributes as the most important for technology: *technology endures years of consumption and use, its manufacturers act responsibly towards their stakeholders, it is produced ethically, it serves more than one purpose and can be used holistically,* and *it does not jeopardize the environment*. Gender had small to strong effects on some of the most im-

portant attributes. That is, only the importance of technology's longevity and that it does not jeopardize environment were on average ranked similarly by both women and men. Meanwhile, the rest of the attributes were on average ranked higher by women. Sustainability consciousness had low to medium to strong effects on some of the most important attributes. In other words, participants with a strong or very strong sustainability consciousness were on average more likely to evaluate the responsibility of companies manufacturing technology towards its stakeholders and ethical production of technology as the most important compared to those with medium sustainability consciousness.

Moving on to the final seventh section, that is, the section investigating the overall sense of importance that sustainability may have on technology, the participants of the current study perceived on average sustainability as important for technology. Gender had a small effect on this. However, women seemed on average to evaluate sustainability as more important for technology than men. On the other hand, sustainability consciousness had a strong effect to the perceived importance of sustainability for technology. The stronger participants' sustainability consciousness was, the more likely they were to evaluate sustainability more important for technology and vice versa. Thus, it seems that the value assigned to sustainability extends to the context of technology as well.

In sum, the results obtained from these sections suggest that the participants of the current study perceive on average sustainability as important for technology providing insight to the second investigation aim. Despite their highly explorative nature they further shed light on sustainability attributes that are valued when it comes to technology: the longevity and versatility of a given technology, and the social, ethical, and environmental responsibility relating to its production. The participants' position to the topic can be concluded to show, at least in the current context, that taking sustainability holistically into account in technology design and development is essentially important.

7 CONCLUSION

This thesis presented a study that intended to investigate how people understand the concept of sustainability when it is observed in the context of technology. In particular, this was investigated by observing the saliency of seven sustainability dimensions identified from previous literature. As an additional aim, it set out to find whether sustainability is perceived as important for technology. Accordingly, this research aim was approached with two research questions:

- How is sustainability understood in the context of technology?
- Is sustainability perceived as important for technology?

The inspection of the research questions was commenced with a literature review into language and its function in relation to mental representation. It was concluded that language as a cognitive function enables the sense making process in that it provides a medium to organize, formulate and express experiences imagined or derived from the world (Burkette & Kretzschmar Jr., 2018). The meanings of words and concepts that are realized as mental representations are socially negotiated, fluid and context dependent (Lotman, 2005; Wittgenstein, 1959) in addition to being embodied (Lakoff, 2006), and thus, also guided by sensory experiences. Therefore, people understand words and concepts uniquely but at the same time within normative rules that enable them to function in various social groups where the meanings are learned and shared (Holtgraves & Kashima, 2008). In other words, the semantic value of language is seen to change depending on actors and their linguistic resources, context, and purpose. Following this, the next part of the literature review focused on notions of the concept of sustainability found outside and within the context of technology. Sustainability is an action-guiding concept enclosing the normatively desirable idea of a comprehensive and continuous state of wellbeing for people and the environment on the planet Earth (Hammond, 2020; Portney, 2015). Despite its holistic nature allowing multiple readings that can be considered problematic for the message of the concept (White, 2013), sustainability is often made sense mainly via environmental aspects. Previous studies have found that sustainability is mainly understood as relating to nature, resource preservation, and biodi-

versity (Barone et al., 2020; Hanss & Böhm, 2012; Simpson & Radford, 2012). From these studies additional dimensions that were salient in the understandings of sustainability were identified. Accordingly, the dimensions of environmental, social, economic, temporal, developmental, confidence, and compromise were seen relevant. Further investigation into sustainability discourse in the field of human-computer interaction showed that initiatives towards sustainability are seen important but the contested concept of sustainability is hindering progress (DiSalvo et al., 2010; Håkansson & Sengers, 2014; Knowles et al., 2018). It also showed that within this context, too, sustainability is often realized as a concept that is charged with aspects relating to environment (Blevis, 2007; Mankoff et al., 2007, Knowles et al., 2018). Yet, the discourse also emphasized that in addition to the environmental dimension of sustainability, the dimensions of social, economic, temporal, developmental, and political were made relevant in this context.

Following this, an internet-based survey was implemented to investigate the designated research questions. Accordingly, the empirical part of the thesis consisted of an online questionnaire that was used to collect data on how the concept of sustainability is understood both in and out of the context of technology and whether it is perceived as important for technology. The survey data (N=235) was mainly collected from the students and personnel of the University of Jyväskylä via email lists. Other participants were reached via personal email. The results showed evidence that sustainability is not considered completely alien from technology as a great deal of the participants had seen the term in relation to technology and had thought about the two together. Accordingly, the associations made with sustainability and technology revealed that on average the combination is thought of especially holistically showcasing especially aspects relating to environmental, developmental and social dimensions. Also, the dimension of confidence was salient. Furthermore, the results suggest that sustainability is perceived on average as important for technology and that it correlates with the sustainability consciousness of an individual. That is, a stronger sustainability consciousness in regard to knowledge, attitudes, and behaviors towards sustainability also accounts for a stronger sense of sustainability's importance for technology. Relating to this, further results showed that technology's ability to endure years of consumption and use, its manufacturers' responsible actions towards their stakeholders, its ethical production, its ability to serve more than one purpose and to be used holistically, and not jeopardizing the environment were on average ranked as the most important sustainability attributes for technology.

Thus, drawing from the results it can be concluded that the participants of the current study showing strong sustainability consciousness understand sustainability as an important element for technology. Sustainability is seen to comprise of several dimensions, but in the context of technology it especially relates to environmental aspects such as recycling and energy, developmental aspects such as innovations and new technologies, and social aspects such as cooperation and distinct values. Furthermore, in the context of technology feelings of confidence and scepticism are more present in relation to sustainability than when the concept is made sense of alone. When combined with technology,

sustainability is quickly connected to electric cars, matters relating to energy and innovations, thus reflecting existing endeavours and the possibilities for achieving sustainability. Therefore, relating to the practical implications of the current thesis, these insights could be valuable for both academics researching the topic as well as for practitioners offering perspectives from the point of view of general public. Furthermore, the results provide novel information on how sustainability is understood in the particular context of technology, something that at least to the knowledge of the current thesis has not been previously investigated.

The results of the current study cannot be evaluated as completely valid. An evident limitation of the current study is the low validity of the implemented questionnaire, specifically its structure and ambiguity. Relating to the question types, the ranking order section showed vagueness. This can be seen to extend to the section relating to the importance of sustainability for technology which, therefore, cannot be considered an entirely valid method to measure this phenomenon. Moreover, the small sample size decreases the validity of the current study as it cannot be said to be representative. That is, the sample was selected for the sake of convenience. Thus, it is not entirely representative of the Finnish population. Finally, in a more general sense, a more precise outlining of the research topic may have benefitted the current study. Given these limitations, future studies should consider applying previously validated measuring instruments for more reliable and valid research. Additionally, it should be assessed whether despite the conventionality and rapidity of survey methods, interviews or field studies in the natural environments where language and meaning making take place would be more comprehensive. Furthermore, with these methods, the issue of ambiguity that may be present when dealing with more abstract topics such as the current one could possibly be tackled.

Finally, this thesis focused on observing the concept of sustainability from the point of view of predetermined dimensions. In terms of future studies, it would however be interesting to investigate how specific technologies are perceived in terms of their actual or assigned sustainability and whether this affects their actual or intended use or purchasing. As the obtained results of this study showed, electric devices and vehicles along with different energy sources were often related to sustainability with regard to technology. Therefore, investigating conceptions relating to such distinct technologies would provide important information about the experience of sustainability from the point of view of the users of those technologies. An interesting direction would also be sustainability aesthetics in regard to ideo-pleasure. In product context, ideo-pleasure relates to whether people's values match the values embodied in a product, such as aesthetic and moral values (Jordan, 2000). Here, the interest thus would be whether sustainable technology is seen to embody the values that are assigned to it contributing to a pleasant experience for those resonating with these values. Arguably this would be especially meaningful in the case of technological initiatives that are being designed for sustainability in order to facilitate their adaptation into use and consequently contributing to the desired change for sustainability.

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APPENDIX 1 REMOVED SUM VARIABLE ITEMS

The variables that were dismissed based on a factor analysis are listed in the box below.

Importance of sustainability for technology [not included items]

22.1 (Env.) *New technology must focus in particular on combating climate change rather than concentrating on all sustainability goals more broadly.*
22.2 (Env.) *It is not possible to develop new technology within environments' limits.**
22.3 (Soc.) *New technology creates significant opportunities to eradicate poverty from the world.*
22.4 (Soc.) *New technology must be developed according to different values than before, because people's values have changed.*
22.5 (Eco.) *Only certain groups of people benefit financially from new technology.*
22.6 (Tem.) *It is possible to inspire people to pursue an alternative future with new technology.*
22.7 (Tem.) *It is too late for new technology to secure the quality of life of future generations.**
22.8 (Pol.) *Designers of new technology must be politically non-aligned in their work.*
22.9 (Pol.) *With the help of new technology, it is possible to revive people's interest in political decision-making, even for those who have not been interested in it before.*

* Inverted item

APPENDIX 2 THE SURVEY QUESTIONNAIRE

KYSELY KESTÄVÄN KEHITYKSEN MIELIKUVISTA TEKNOLOGIAN KONTEKSTISSA

Tervetuloa!

Tämän kyselytutkimuksen tavoitteena on selvittää miten kestävän kehityksen (engl. sustainable development) käsite ymmärretään teknologian kontekstissa. Se pyrkii määrittämään mitkä ovat keskeisimmät mielikuvat ja ulottuvuudet, joiden kautta käsite mielletään, ja miten yksilön tietoisuus kestävästä kehityksestä sekä tämän kielelliset valinnat vaikuttavat mielikuvan muodostumiseen. Kyselyyn vastaaminen ei edellytä aiempaa tuntemusta aiheesta ja siihen voi vastata kuka tahansa. Kysely on osa Jyväskylän yliopiston kognitiotieteen pro gradu -tutkielmaa.

Tähän suomenkieliseen verkkokyselyyn vastaaminen vie noin 15-20 minuuttia vastaajasta riippuen. Vastaukset käsitellään luottamuksellisesti ja hyvän tieteellisen käytännön mukaisesti, eikä yksittäistä vastaajaa voi tunnistaa raportoinnista. Pakolliset kysymykset on merkitty *-merkillä.

Vastattuasi kyselyyn voit halutessasi osallistua S-ryhmän lahjakorttien arvontaan (5 x 10€) jättämällä nimesi ja sähköpostiosoitteesi kyselyn lopussa ohjeistetulla tavalla. Arvonnassa annetut yhteystiedot eivät ole yhdistettävissä muihin kyselyssä annettuihin vastauksiin.

Kyselyyn toivotaan vastauksia sunnuntaihin 1.11.2020 mennessä.

Jokainen vastaus on tutkimuksen kannalta merkittävä. Kiitos jo etukäteen vastauksestasi!

Lisätietoja kyselystä:
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Olen ymmärtänyt yllä esitetyt tiedot ja hyväksyn vastauksieni käytön tässä tutkimuksessa. *
- Kyllä

Syntymävuosi *
[Alasvetovalikko; 2005-1930]

Sukupuoli *
- Nainen
- Mies
- Muu
- Haluan itse määrittää [Tekstikenttä]
- En halua vastata

Tämänhetkinen asuinpaikkakunta Suomessa *
Jos asut ulkomailla, valitse alasvetovalikon lopusta vaihtoehto "En asu Suomessa".
[Alasvetovalikko; Akaa-Äänekoski, En asu Suomessa]

Korkein suoritettu tutkintoaste / tällä hetkellä suoritettava tutkintoaste *
- Peruskoulututkinto tai vastaava
- Ylioppilastutkinto tai vastaava
- Ammatillinen tutkinto tai vastaava
- Alempi korkeakoulututkinto tai vastaava
- Ylempi korkeakoulututkinto tai vastaava
- Tohtorintutkinto tai vastaava
- Muu, mikä? [Tekstikenttä]

Elämäntilanne *
- Työssäkäyvä
- Työtön
- Kotivanhempi
- Opiskelija
- Eläkeläinen
- Muu, mikä? [Tekstikenttä]

Käytössä olevat kielet *
Kerro äidinkielesi lisäksi ne pääasialliset kielet, joita käytät työskentely-ympäristössäsi (esim. töissä tai opiskelussa) sekä vapaa-ajalla (esim. ystävien tai perheen kesken). Jos käytät vain yhtä kieltä, merkitse siinä tapauksessa kyseessä oleva kieli kaikkiin kohtiin. Jos käytät useampaa kieltä yhtä paljon, valitse se kieli, joka on sinulle merkityksellisin kyseisessä kontekstissa.

Äidinkieli *	[Tekstikenttä]
Pääasiallinen kieli työskentely-ympäristössä *	[Tekstikenttä]
Pääasiallinen kieli vapaa-ajalla *	[Tekstikenttä]

1. Listaa viisi ensimmäistä mielleyhtymää, jotka tulevat mieleesi termistä kestävä kehitys (engl. sustainable development). (Millä kielellä tahansa.) *
Mielleyhtymät voivat olla mitä tahansa edellä mainitusta termistä mieleesi nousevaa.
1. * [Tekstikenttä]
2. * [Tekstikenttä]
3. * [Tekstikenttä]
4. * [Tekstikenttä]
5. * [Tekstikenttä]

2. Listaa viisi ensimmäistä mielleyhtymää, jotka tulevat mieleesi termeistä kestävä kehitys ja teknologia (engl. sustainable development and technology). (Millä kielellä tahansa.) *
Mielleyhtymät voivat olla mitä tahansa edellä mainituista termeistä mieleesi nousevaa.
1. * [Tekstikenttä]
2. * [Tekstikenttä]
3. * [Tekstikenttä]
4. * [Tekstikenttä]
5. * [Tekstikenttä]

3. Missä teknologian yhteydessä olet viimeksi kohdannut termin kestävä kehitys (engl. sustainable development)? (Millä kielellä tahansa.) *
[Tekstikenttä]

4. Arvioi aluksi seuraavia kestävän kehityksen väittämiä. *
[Likert-asteikko; 1-5]
- Kestävä kehitys edellyttää, että yhtiöt käyttäytyvät vastuullisesti työntekijöitään, asiakkaitaan ja tavarantoimittajiaan kohtaan
- Köyhyyden kukistaminen maailmasta on ehdotonta kestävän kehityksen kannalta
- Kestävän kehityksen saavuttaminen edellyttää, että kaikilla maailman ihmisillä on pääsy hyvään koulutukseen
- Elävien olentojen monipuolisuuden säilyttäminen on ehdotonta kestävän kehityksen kannalta (biologisen moninaisuuden säilyttäminen)
- Ihmisoikeuksien kunnioittaminen on välttämätöntä kestävän kehityksen kannalta
- Kestävä kehitys edellyttää hyödykkeiden ja palveluiden reilun jakautumisen ihmisten kesken kaikkialla maailmassa
- Veden kulutuksen vähentäminen on välttämätöntä kestävän kehityksen kannalta
- Kestävän kehityksen kannalta on oleellista, että ihmiset tulee kouluttaa siten, että he osaavat suojautua luonnonkatastrofeilta
- Sellainen kulttuuri, jossa konfliktit ratkaistaan rauhanomaisesti keskustelemalla, on välttämätöntä kestävän kehityksen kannalta

5. Kerro seuraavaksi missä määrin olet samaa tai eri mieltä seuraavien kestävään kehitykseen liittyvien väittämien kanssa. *
[Likert-asteikko; 1-5]

- Mielestäni tarvitsemme tiukempia lakeja ja säädöksiä ympäristön suojelemiseksi
- Mielestäni on tärkeää ryhtyä toimenpiteisiin niitä ongelmia vastaan, jotka liittyvät ilmastonmuutokseen
- Mielestäni luonnonvarojen käyttäminen yli tarpeidemme ei uhkaa tulevien sukupolvien terveyttä ja hyvinvointia
- Mielestäni köyhyyden vähentäminen on tärkeää
- Mielestäni yrityksillä on velvollisuus vähentää paketoinnin sekä kertakäyttöisten tuotteiden käyttöä
- Mielestäni rikkaissa maissa toimivien yritysten tulisi antaa köyhissä maissa toimiville työntekijöilleen samat olosuhteet kuin mitä työntekijöillä rikkaissa maissa on
- Mielestäni jokaiselle tulisi antaa mahdollisuus sen tietämyksen sekä niiden arvojen ja taitojen hankkimiseen, jotka ovat välttämättömiä kestävään elämiseen
- Mielestäni kaikkialla maailmassa jokaiselle tulee antaa samat mahdollisuudet koulutukseen ja työllistymiseen sukupuolesta riippumatta
- Mielestäni meidän, jotka elämme tällä hetkellä, tulisi varmistaa, että tulevaisuuden sukupolvilla on mahdollisuus nauttia vähintään samasta elämänlaadusta kuin mistä me nautimme nyt

6. Arvioi lopuksi omaa käyttäytymistäsi kestävään kehitykseen liittyen.
[Likert-asteikko; 1-5]

- Kun minulla on mahdollisuus, erottelen aina ruokajätteen muista roskista ennen roskien viemistä jätekeräykseen
- Tuen avustusjärjestöä tai ympäristöryhmää
- Ostan usein kierrätettyjä hyödykkeitä internetistä tai kivijalkamyymälästä
- Vältän ostamasta hyödykkeitä yrityksiltä, joilla on huono maine työntekijöidensä ja ympäristön huolehtimiseen liittyen
- Teen tekoja, jotka auttavat köyhiä ihmisiä
- Olen muuttanut omaa elämäntapaani vähentääkseni jätettä (esim. heittämällä vähemmän ruokaa roskiin tai välttämällä materiaalien tuhlaamista)
- Kierrätän niin paljon kuin pystyn
- Osoitan samanlaista kunnioitusta kaikkia sukupuolia kohtaan iästä riippumatta
- Käyttäessäni tietokonetta tai puhelinta viestittelyyn tai pelaamiseen tai muuhun vastaavaan, kohtelen siellä aina muita yhtä kunnioittavasti kuin oikeassa elämässäkin

7. Kerro niistä tilanteista, joissa olet itse miettinyt kestävää kehitystä ja / tai se on ollut puheenaiheena muiden kanssa. Kenen kanssa ja missä yhteydessä kestävä kehitys on ollut esillä?
[Tekstikenttä]

Mieti seuraavaksi omaa teknologian käyttöäsi. Järjestä seuraavien kysymysten väittämät kokemaasi tärkeysjärjestykseen.
[Alasvetovalikko; 1-4]

8. *
Käyttämäni teknologia ei vaaranna ympäristöä
Käyttämäni teknologia on mahdollista kierrättää
Käyttämäni teknologian valmistuksessa käytetään uusiutuvia luonnonvaroja
Käyttämäni teknologia ei tuota jätettä

9. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

10. *
Käyttämäni teknologia edistää ihmisten välistä tasa-arvoa
Käyttämäni teknologia on tuotettu eettisesti
Käyttämäni teknologia luo mahdollisuuksia kaikille ihmisille
Käyttämäni teknologia edistää ihmisarvoa

11. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

12. *
Käyttämäni teknologia on yritysten kannalta liiketoiminnallisesti kannattavaa
Käyttämäni teknologia inspiroi ja synnyttää uusia liiketoimintaideoita
Käyttämäni teknologia luo uusia työpaikkoja vähentäen työttömyyttä maailmassa
Yritykset, jotka valmistavat käyttämäni teknologian, toimivat vastuullisesti työntekijöitään, asiakkaitaan ja tavarantoimittajiaan kohtaan

13. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

Mieti vielä omaa teknologian käyttöäsi. Järjestä seuraavien kysymysten väittämät kokemaasi tärkeysjärjestykseen.
[Alasvetovalikko; 1-4]

14. *
Käyttämäni teknologia kestää vuosien kulutuksen ja käytön
Käyttämäni teknologia on sellaista, että se vastaa jo tänään tulevaisuuden tarpeisiin
Käyttämääni teknologiaa arvostetaan vielä vuosienkin jälkeen

Käyttämäni teknologia ei vaaranna tulevien sukupolvien elämänlaatua

15. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

16. *
Käyttämäni teknologia perustuu tieteellisen tutkimuksen tuloksiin
Käyttämäni teknologia hyödyntää uusimpia innovaatioita
Käyttämäni teknologia mukautuu käyttäjien erilaisiin tarpeisiin kaikkialla maailmassa
Käyttämäni teknologia ei palvele vain yhtä tarkoitusta, vaan sitä voi käyttää kokonaisvaltaisesti useampaan tarkoitukseen

17. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

18. *
Käyttämälläni teknologialla ei ole mahdollista huijata ihmisiä
Voin luottaa, että käyttämäni teknologia toimii eri tilanteissa
Käyttämälläni teknologialla on mahdollista vaikuttaa positiivisesti ihmisten elämään
Käyttämäni teknologia on helposti ymmärrettävää ja käytettävää

19. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

20. *
Käyttämäni teknologian käytön kustannukset ovat samat ihmisestä riippumatta
Käyttämäni teknologian tekninen suorituskyky on korkea
Käyttämäni teknologian käyttö ei vaadi uusien taitojen opettelua
Käyttämäni teknologia on yhtä saatavilla kaikille maailman ihmisille

21. Voit halutessasi kertoa miksi valitsit juuri tämän järjestyksen.
[Tekstikenttä]

22. Arvioi vielä seuraavia väittämiä liittyen siihen, millaista uuden teknologian tulisi olla. *
[Likert-asteikko; 1-5]

- Uuden teknologian avulla on mahdollista inspiroida ihmisiä tavoittelemaan **vaihtoehtoista tulevaisuutta**
- Uutta teknologiaa tulee kehittää **erilaisten arvojen** mukaan kuin aiemmin, sillä ihmisten arvomaailma on muuttunut
- Uuden teknologian **menestys** on mahdollista mitata myös muutoin kuin rahallisesti
- Uuden teknologian tulee sallia vallitsevien **valtarakenteiden kyseenalaistaminen**

- Uuden teknologian tulee mahdollistaa ja tukea ihmisten välistä viestintää ja toimintaa yhdessä siten, että se tukee **maailmanlaajuista joukkoaktivismia** ja **demokratiaa**
- Uuden teknologian kehityksen tulee ottaa **kokonaisvaltaisesti** huomioon sen vaikutukset niin **yksilön** kuin **yhteiskunnan** tasoilla
- Uuden teknologian tulee mahdollistaa **korkeatasoinen elämänlaatu** myös niillä alueilla, joihin ilmastonmuutoksen aiheuttamat **luonnonkatastrofit** tulevat vaikuttamaan voimakkaimmin
- Uuden teknologian tulee poistaa **epäoikeudenmukaisuutta** ja **epätasa-arvoa** kaikilla elämän osa-alueilla
- Uudesta teknologiasta **hyötyvät rahallisesti** vain tietyt ihmisryhmät
- On liian myöhäistä, että uudella teknologialla olisi mahdollista turvata **tulevien sukupolvien elämänlaatu**
- Uuden teknologian tulee keskittyä taistelemaan erityisesti **ilmastonmuutosta** vastaan eikä niinkään keskittyä kaikkiin kestävän kehityksen tavoitteisiin laajemmin
- Uuden teknologian suunnittelijoiden tulee olla työssään **poliittisesti sitoutumattomia**
- Uutta teknologiaa ei ole mahdollista kehittää **ympäristön kantokyvyn** rajoissa
- **Yhteiskunnallisen hyvinvoinnin** tulee ohjata uuden teknologian kehittämistä rahallisen voiton tavoittelun sijaan
- Uusi teknologia luo merkittäviä mahdollisuuksia **köyhyyden poistamiseksi** maailmasta
- Uutta teknologiaa tulee kehittää jo nyt sen periaatteen mukaan, että tulevaisuudessa **luonnonvarat** on käytetty loppuun
- Ihmisten kiinnostus **poliittiseen päätöksentekoon** on mahdollista elvyttää uuden teknologian avulla myös niiden kohdalla, jotka eivät aiemmin ole olleet kiinnostuneita siitä
- **Paikallisten yhteisöjen ihmiset** tulee ottaa mukaan heille suunnatun uuden teknologian suunnitteluun

23. Kerro lopuksi onko kestävä kehitys jotain, mitä olet miettinyt suhteessa teknologiaan. Kuvaile kokemustasi tarkemmin (esim. milloin, missä yhteydessä, miksi, jne.). *
[Tekstikenttä]