



# **A Study of ICT Student's Views on Sustainable Technology Development**

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# Abstract

In this thesis, I focused on sustainable technology development and services, and how they are understood by Finnish university students in modern society. Students discussed sustainable development in technology and services, in the public system, and private sector, and used the EU's green targets as a base for it. The thesis is focusing to analyze the digital technology development inside the European market areas and takes into account the cultural, economic, and geographical aspects about the topic. The reason for writing this thesis is understanding the values of digital product users' backgrounds, habits, and values, because these have become an important part of sustainable change strategies and sustainable technology development. For this, I am conducting Nexus Analysis, which leads our focus to three main topics: discourses in place, historical body, and interaction order, to support a deeper understanding of students' actions and decisions.

I am taking the discourses of Finnish students, future developers, into analysis on sustainable change of technology development, and also what kind of values the student discourses contain, and what kind of methods and features should be remembered in digital technology development when trying to change those values and behavior. This scientific work includes familiarizing with previous research made on the topic, analysis of 163 student essays with quantitative data analysis, as well as qualitative nexus analysis where the focus is on discourses in place, historical body, and interaction order. Quantitative data gave me an overall understanding of favored topics and opinions by the students and nexus analysis provided me a deeper understanding of these student opinions and actions. This thesis is made as a collaboration with INTERACT research group which provided me the students' essay materials for the analysis.

As a result, I provided guidelines and important factors for behavioral and background analysis, but also, what kind of values are respected by students in the sustainable change. The most highlighted aspects to remember in the future development were focusing on transparency in organization processes, respecting local habits and interests when making marketing strategies, and also what kind of features are respected by the current university students studying in the information and communication (ICT) field. Another view is taken from employers, when sustainability is wanted to be a part of the company's strategy and what features need to be remembered to improve the sustainability change efficiency in highly competitive markets. These values and factors should be remembered when designing new sustainable products and trying to gain the most efficient change strategies, also in marketing and consumer communication sectors.

In conclusion, I provided two lists as guidelines for supporting companies and organizations for more efficient sustainability development strategies. It includes topics that need to be discovered before development, what features need to be assimilated into product development, and also, what kind of values are respected by the people depending on the market area location. These matters will not guarantee success but will be most likely to gain more attention and interest in local markets where the product or change is targeted. This information can be used by organization employers in their processes or researchers in further analysis and research about sustainability changes and strategies, as a regional strategy guideline or targeted sustainable technology development guideline.

## *Keywords*

**Sustainable development, Interaction Design, User Interface, Consumption habits, Green EU, participatory design, Nexus analysis**

## *Supervisor*

**Postdoctoral researcher, Fanny Vainionpää**

# Foreword

Sustainable development has been a great factor in businesses and organizations during the last decades. Sometimes individuals' behavioral changes towards green can be underestimated and their impact is not seen as strong as organizations, thus European Unions' and society's funding are not directed to consumers. I chose this topic for my thesis because I find it interesting and important to understand consumer behavior in the modern world. Sustainability values differ between countries and areas, making it challenging to have only one strategy inside the organization. I find that sustainability is a variable value and essential matters are felt differently. Climate change is a global problem, but in itself, it can be felt as a significant thing leading people to thought, can they affect or not, but especially how. I believe that globally we can make a difference, but we have to consider values and specific readiness for changes in certain areas. That is why making a *nexus analysis* of northern Finland's students' perception should be considered as one element when planning applications and services for the area where we want changes to happen.

My participation in this thesis began when I joined the INTERACT research group as a research assistant and started to familiarize myself with the topic. I quickly noticed how different values people have depending on the area they are residing, leading to rising interest in sustainable planning at a behavioral level.

This thesis is made as a collaboration with INTERACT research group which provided me the students' essay materials for the analysis. My supervisor Fanny Vainionpää and Marianne Kinnula made it possible to get a chance to deepen my understanding of sustainable development and also, allowed me to work as a research assistant. Thank you very much for making this opportunity possible through the data aspect and via employment.

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# 1. Introduction

In this chapter, I am going through the basic concepts and themes of this thesis. I will explore the concept of sustainable development and innovations that are present in modern society, that are believed to influence sustainable technology change. Technology is believed to play a major part in sustainable change (Bahrke & Manoury, 2022) but how can individual consumers play a part in these common targets? This leads to the introduction of different sustainability actions, beliefs, reasons behind the sustainability decisions, and methods of how consumers' habits are influenced by different actors. I will use the terms *consumers* of the products and *citizens* of the society, to describe the individuals so that they can be understood from a relative point of view in different parts of this thesis. Thesis stakeholders are introduced, and I will take a peek at collected data of student essays, that are used for understanding sustainable thinking among university students. At the end of this chapter, research questions and main goals are introduced.

Sustainable development is an action or principle where human development goals are created together with the ability to save or recover the natural resources and ecosystem services, that are seen as a necessity for society. The ultimate goal for these actions is a state of society where resources and human living conditions are continued without undermining or destroying the stability of the natural system. The global crisis has raised worry around the world and many actors are preparing a change for the future. This development has to meet the needs of current generations without destroying the possibilities of future generations. (United Nations Brundtland Commission, 1987) One major factor in this development is Sustainable Development Goals (SDGs) that were established in 2015. (United Nations, 2015) The SDGs emphasize the interconnected environmental, social, and economic aspects of sustainable development, by putting sustainability at their center. Also, the European Union (EU) has set ambitious targets for 2050 which require the participation of every EU country. This is called the European Green Deal which is policy set in 2020 by the European Commission. Their target is to review matters related to climate and environmental issues and provide new legislations for future sustainable development (European Commission, 2019). That leads to the question; how can technology development affect this rigid behavior in modern days? This challenges services provided by organizations and society. The mentioned targets by the EU is at the center of the sustainability change revolution and these solutions need to be changed and modified to serve the global problems, but also be adaptable by local actors and users.

Sustainable development offers a lot of research and theories for companies, but also for the individual consumers. Getting a proper understanding of the differences between city people and people from the countryside was seldom seen. When it comes to consumers' behavior, where people live plays a major part in the results, leading to a situation where detailed research information was difficult to find. Not only applications and services should be designed to support sustainable targets, but consumer behavior should also change with it. Technology designed to bring about desirable behavior and attitude changes is referred to as Persuasive Technology. (Fogg, 2009) It is believed that technology is never neutral; rather, it has always influenced people in one way or another. (Oinas-Kukkonen & Harjumaa, 2009) In many cases, this influence can be seen as a side effect, but in the last few years, many applications have been developed with a change of affecting users' behavior in many ways, including marketing, health, safety and security, and environmental sustainability. With the increasing growth of e-commerce, mobile applications, and versatile software development, it is predicted that marketing will continue to attract persuasive technology researchers and developers in the future, creating whole new methods to affect consumer habits, even to help achieve a better, sustainable world. This thesis is focused on the user consumer-based sustainability development, reasons and backgrounds of individuals thinking, and how consumer behaviour can be influenced by persuasive, and intentional, sustainable technology development. Green future and technology have

been trending in the last years and many companies have changed their organization methods to more sustainable ways.

Finland have ranked well in international studies that follow education levels. Not only faculties and teaching are high quality, but students also have the freedom to explore and experiment too. Based on the statistics from 2022 (Ministry of Education and Culture, 2022) three in four Finnish people aged 25–64 hold an upper secondary school certificate and one in three holds a higher education degree. One reason for this achievement is that schools have no rankings, believing that students can be developed during their educational journey. It is free for all Finnish citizens, and it is available for everyone from early childhood education to higher education degrees in Finland. There are currently 160 000 students studying in the universities in Finland and 16 % of them are studying technical-related studies. In the Finnish universities of applied sciences, this percentage is almost 25%, making the technology field the biggest sector at the university level. (Tilastokeskus, 2022) One great difference from other countries is that the Finnish government does not charge tuition fees to its citizens. The core curriculum is handled by tripartite training committees (government, industry, and education and training providers) to guarantee the needs and quality of the education. Technology development has a strong impact on provided education options. Finland is famous as one of the world's technology centers. Technology companies account for over 50 percent of Finland's total exports (services and goods). Approximately 338,000 people work for companies in the technology sector in Finland. If we consider all the spill-over effects of the industry on society, about 720,000 Finns have jobs thanks to the technology industry. Technology companies also play an important role in building Finland's future success. Companies in the technology sector make 65% of all business R&D investments. Technology companies invest approximately EUR 6 billion in Finland every year. (Teknologiateollisuus, 2022)

One way to work towards a sustainable future is to focus on digital product planning and participatory design of the digital product since these products, services, and applications have a long-term impact on the planet and sustainable development (Busse et al., 2009). It is seen that modern applications and software development are not in harmony when it comes to sustainable development, noticing the environment, resources, and social economy. Many digital product designers have neither learned during their education how to design for sustainability (Blevis et al., 2015) nor their current employers are not requiring these skills. It has come to the point where designers of digital products have a responsibility to design sustainably, for which there is currently too little awareness. Reasons for the lack of environment-friendly solutions can be its overwhelming concept or even its expenses. Nowadays, sustainable digital product planning is increasing its (Newman, 2020) and that is one reason I decided to focus on the topic in my thesis. My thesis focuses on sustainable digital product design from the perspective of human-computer interaction. One of the targets is to find solutions for consumer habits because consumers are often seen as a user only. A new way of sustainable technology development is encouraging businesses to make products more interactive and consumer participative when it comes to change to better outcomes for users or even for society. This way the EU's and SDGs goals have better changes to be achieved.

My master's thesis is made as a part of my Information Processing Science Master's degree. Human-computer interaction as a topic has always been my interest. During my master's studies, I focused on information system studies and eventually more and more on human-centered user experience and user interface (UX/UI) design. I have seen that users are at the center of digital products, and I have always been cheering for consumer participative development. Unfortunately, a human mind can be strict and unchangeable, leading to questioning increasing expenses or changes from customary habits. That leads to questions and challenges for product developers who have decided to pursue greener development and user environment, with even better carbon footprint. There are a few research questions I'm about to answer in this thesis that are mentioned before. Nexus analysis was used to gain a deeper understanding of the first research question: *what are the students' thoughts and opinions about sustainable development?* Next, my approach to this problem is to find and discuss

solutions for sustainable design and find key elements to answer the second research question of; *how can we use the understanding of elements behind students thinking to change human behavior in sustainable technology development?*

To answer the research questions, I first introduce literature on sustainable technology development. Then I present my research methods, including data collection from students' essays, quantitative analysis, and use of nexus analysis to have a deeper understanding. After this, I present the data that was collected from the university students, leading to the analysis and wrap-up of this material and essays giving the results of this research. At the end of the thesis, I discuss gained information and results, leading to the conclusion of the topic. Together with the literature review and results, essay material is compared to previous research, so that similarities and differences can be shown. This leads to the development of guidelines about matters that have to be remembered when planning persuasive and sustainable digital products and also, instructions and information about factors that are affecting consumer behavior when trying to change customers' habits.

This thesis was made in collaboration with the University of Oulu's INTERACT research group. The topic and theme of this thesis were initiated together with Fanny Vainionpää and Marianne Kinnula who are both part of the research group. The thesis project started with an analysis of student essays. This material was collected from a course that was held by the faculty of Information Processing Science at the University of Oulu. These outputs were part of the course accomplishment and students were allowed to choose whether their essays can be used as anonymous research material, or not. In the student essays, students were instructed to analyze the European Green Deal – program, its benefits, and disadvantages, but also who is playing an important role during change, and how they see themselves as developers and problem solvers.

## 2. Background

In this theory chapter, I will introduce literature on sustainable development from an organizational perspective and discuss how technology can be utilized to affect citizens' or consumers' behavior. Secondly, I take sustainable technology development under process and explain how it has raised popularity among individuals, companies, and society. At the end of this chapter, I take a look at user experience and user interface design as part of persuasive development, and what kind of results it can provide when we consider a greener and more sustainable future.

Sustainable development is a wide area, and it has raised popularity in the last decades significantly. With sustainable development, I mean economic, service, or product development that is conducted without depletion of natural resources and meets the needs of the present without compromising the ability of future generations to meet their own needs (the World Commission on Environment and Development, 1987). Sustainable development in this thesis is covering technology development and services, energy solutions, and societal sides in the development, by taking individuals' perspectives under discussion. I am covering the history and also current strategies in sustainable technological innovations and development, but also research factors and reasons behind individuals thinking and current knowledge and awareness of green actions in everyday life. The European Green Deal and targets are occasionally in the news and organizations are more focused on advertising their part and actions toward a more sustainable greener world. I am using previous research to cover the scientific part about consumers and individual habits but also reports, news, and other publications to understand methods and differences made in the companies. I am limiting my introduction to a sustainable world and organizations, persuasive techniques used by the companies, green marketing, and to green thinking of individuals. A combination of these will give me a great understanding of the reasons and influencers behind the current level of interest and understanding. Few technologies and services are seen as important with this: mobile applications, e-commerce, and social media, therefore these will be added to background material to improve the understanding of modern society.

### 2.1 Sustainable world and organizations

Sustainable Development Goals (SDGs) are a collection of 17 interlinked global goals designed to be a "shared blueprint for peace and prosperity for people and the planet, now and into the future (United Nations, 2015). These goals were presented in 2015 and their main target was to offer a holistic approach to include all dimensions of sustainability. Even though the SDGs mainly focus on ecological sustainability and protecting nature by counteracting climate change, it also includes the social approach by compacting poverty, inequality, and human rights to education and health care. The SDGs were set up by the United Nations General Assembly (UN-GA) which is trying to achieve its goals by 2030. Targets are listed as follows: no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequality, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice, and strong institutions, partnerships for the goals. Each target is strictly followed by using meters and measures, so progress will be seen. SDGs are wide and it does not present technological innovations themselves, but digital products can be understood as important tool and method in counteracting climate change.

The reason why SDGs are introduced and included in this thesis is because of their relevance when I reflect on students' essays and their topics. Also, human-computer interaction research and interface design has not yet made much research about it. International workshops are noticing SDGs and are discussing each responsibility and how can human-computer interaction design affect targets.



(Pargman et al., 2019) All people strives to meet their needs in a sustainable way to protect and restore the health and integrity of the Earth's ecosystem and life, without endangering the ability to meet the needs of future generations and without exceeding the long-term limits of the Earth's ecosystem capacity. Such satisfaction of needs also covers consumption, which should be follow sustainable design and be realized in a common, highly moral partnership of market entities: producers, service providers, retailers, and consumers. To achieve such state of reality, Sustainable Development Goals (SDGs) must be widely known and socially accepted. (Pisano et al., 2012)

Change to sustainable production and consumption habits is seen as an important aspect, which includes various agendas, but how to guarantee this change in a constantly alterable world? This is a challenge since economic structures can have different cultures and factors, also when discussing governance approaches. Over-consumption and increasing poverty were seen as a problem and sustainable development was created to counterattack it. This development is planned to meet the needs of the present without taking away the ability of future generations to meet their own. The global structure should be reshaped, giving the environmental dimension more weight than the social and economic dimensions (WCED, 1987). Hart & Milstein (1999) have divided the countries into three divisions because economic balance and methods are affecting opportunities and solutions for habit changing. First one, *consumer economics*, has a high wealth per capital level and poverty is occasional in these countries. Consumption culture is thriving and usually, people do not need to worry about necessities. The second level is *emerging economies*, like China, which is rapidly changing and developing into a modern economy, where consumption levels are rising. *Base-of-the-pyramid (BOP)* economies are reflected in societies where the majority of the population is living on a few dollars per day. Consumption levels are relatively low in consumer markets, besides these markets are of low importance to globally noticed systems. (Hart & Milstein, 1999)

Sustainability does not always mean that buying and consuming goods have to be always reduced. This highly depends on the area where a change of consumption habit and its solutions are occurring. These market areas are facing challenges that need to be changed with technological innovation or consumer habits. Hart and Milstein (1999) condensed that consumer economics, like Western and Northern Europe, needs to dramatically reduce its material use per consumer, but also lower resource use while maintaining increasing economic output. When emerging economies are following behind the previously mentioned one, they are assumed to jump straightly to sustainable consumption and change their production structures to meet the requirements. The main challenge of BOP economies is to ensure consumption and production to face the basic needs and cover sustainable growth. Since emerging and BOP economies are either following or developing to answer society's needs, major consumption behavior changes are inevitable in consumer economics.

Sustainable development is an organizing principle for meeting human development goals while also sustaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend. The desired result is a state of society where living conditions and resources are used to continue to meet human needs without undermining the integrity and stability of the natural system. Navarro and Fayolle (2019) state that moving to a greener and more sustainable society is a must as the challenges of global warming, environmental degradation, and resource depletion become increasingly pressing. It is widely seen and recognized by many actors in each step of society. Helping the world transition to a sustainable, carbon-neutral society is a complex step that requires a big transformation for our economies and individual lifestyles. To meet this challenge, more public and private financing must be directed to sustainable projects. The financial system and sustainability will need to be closely connected, not forgetting the participation of the end user, and consumers with their wills and intentions.

Environmental issues have been of growing importance in today's society and consumers are taking environmental concerns into decision-making when they are making purchases. This has led to a situation where businesses sometimes tend to advertise themselves as sustainable eco-companies.

Unfortunately, many companies tend to exaggerate their ecological offerings when they have made minimum changes in their methods. This is often about the recyclability or production methods of their products (Ahern et al., 2013). This trend has increased its popularity in the last few years. This so-called *greenwashing* can be considered a specific type of disinformation in advertising. Advertising is proclaimed to have the power to affect social change in human behavior. There are four reasons why companies are decided to choose this way. First, consumers have an increased demand for environmentally friendly products. Secondly, sales of green products are rising, because the green trends have raised in the last few years. Third, government regulations are supporting environmental objectives. Just like SDGs and the EU are providing information and development support for companies that decide to move towards greener outcomes. Fourth, there are no international industry-wide laws regulating green promotion. This is hard to follow globally since products and services are produced around the world and locations of production steps can vary depending on development. Also, why should consumers be responsible for paying for this change, when production effects and pollution is the greatest polluting factor in the world? (Horiuchi et al., 2009) This might result in a negative impact on the purchase intentions of legitimate green products, consequently damaging a crucial aspect of dealing with the environmental crisis. (Kilbourne, 1995) One key element between false and real green products is usually pricing.

Business sectors have a great impact on sustainable consumption and production- This includes all the business units: micro and macro enterprises, cooperative networks, and transnational corporations. Radical changes are occasionally required and new innovative thinking from business, government, and company stakeholders is needed in this kind of approach. Traditional drivers that are controlling the choices of the company include the basic needs; generate profit, manage risks, reduce costs, and achieve internal goals. Huge companies, from now on cited as *mega brands*, have external drivers to increase shareholders' value, satisfy customers around the globe, and even make difference in the local societies. These businesses have a huge impact on consumers' awareness of sustainability and green products, therefore significant changes should happen within the organization to create a base for a greener future. But the economy is not a constant factor and global demand is increasing all the time. Development and organizational methods cannot be copied between the companies, so a fast-changing environment requires preparedness and resources. (Tukker & Tischner, 2017)

Technological solutions and business practices have been affected by environmental crises over the past 20 years. Scientific evidence of climate change has made frameworks for businesses. Stern (2006) highlights the support and emergence of low-carbon technologies; hence companies have started to develop solutions to find alternatives to fossil energy. This contributes to a wider action from governments to guarantee a low risk of disruptions to economic and social activities. There are challenges. Rising expenses of energy and governments' taxation are increasing when it comes to fossil fuels. Consumer ability to answer these changes is limited, which is giving the negative effect of radical changes. This has changed businesses radically from traditional material-intensive products to experience-based products. (Kleanthous & Peck, 2006) This drives companies to focus and create business models around immaterial value.

Companies have designed different ways to present attributes of products and services as sustainable: they can promote a green lifestyle; they can address the connection to the biophysical environment, or they can promote a corporate image of environmental responsibility (Banerjee et al., 1995). Traditionally companies have used functional or fact-based information as a highlighted strategy to inform consumers, therefore impacting the user in rational ways. Since green products are highly demanded and competition is high, businesses have changed their strategies more towards *image-based emotional appeals*. (Hartmann et al., 2013) According to previous research, the goal of green advertising nowadays is primarily to make the consumers feel good about themselves emotionally when choosing a green product or service, which might lead advertisements to a low level of factual green claims. (Segev et al., 2016) All of these marketing attempts have led to the *green pricing* trend, which refers to optional utility service that allows customers of traditional utilities to support a greater

level of utility investment in renewable energy by paying a premium on their electric bill to cover any above-market costs of acquiring renewable energy resources.

Raising the amount of sustainable financing is needed to protect the climate since the markets for green and social bonds are growing fast. Green changes in organizations can be slow and expensive, and it can be seen in the share size in the markets, but it can also be an excellent investment for the future. We have no choice but to create a greener future and make our climate sustainable, but this transition also can help Europe and the world in many ways. This is a huge opportunity to modernize cities, reduce Europe's energy dependency, grow the economy, and create jobs, even though old ones are disappearing. (E. Navarro & Fayolle, 2019) Of course, COVID-19 pandemic reduced the speed of development in the last years and current markets have to face the shortcomings of global supply chains and focus on the necessities such as medical equipment and different components. In the long run, we need digital and green solutions that work also beyond 2030 and this will only be possible if political ambition and economic reality go hand in hand. Working economical solutions also require contributions from individuals and giving a challenge for decision-makers to encourage consumers for this kind of behavior when it comes to willingness and financial sides are considered in everyday actions. (Schwab, 2020) Current green finance and market ways have also gained critique over the years. The importance of green finance is established, society's reflections should focus on the role of public powers in its development since they can make a difference. The whole green trend is believed to be just hard greenwashing and lowering the credibility enormously, leading to thinking that shutting down proven greenwashing attempts seems to be the first step to be done by regulations. It has to be made without commercial and market value thinking, luckily going to better direction.

One traditional way to impact consumers is traditional commercial marketing. This kind of marketing has influenced the level of affluence and technology. (Peattie, 1995) It is seen as a good method to promote consumer society and materialistic lifecycles; therefore, it can impose nowadays problems on the social and natural environments. With the right use and design, it has the potential to increase the popularity of sustainable products and services. This viewpoint created the concept of *sustainable marketing*. When previously marketing was about satisfying customers' needs, sustainable marketing focuses on creating a relationship with the social and natural environments too. By promoting its nature-friendly impact it can increase the given consumer experience. But it just cannot be only a marketing trick, socio-ecological changes have to be faced inside the organization. It takes the whole product's life under reconstruction, scope depending on the product naturally, so it might have direct or indirect impacts on nature in different production phases.

Sustainable products and services might require more expenses than traditionally produced offerings. This once again includes all the steps of the product life cycle. Some customers are willing to pay extra for green products. Usually, these customers are aware of sustainable life-cycle costs and in these times, when energy prices are increasing, it is important to inform these things. (Belz, 2001) One key challenge is that social and environmental qualities cannot be inspected before purchase or experienced after the purchase. This is why a company needs a strategy to build its credibility because it is acting of great importance in the markets. Possible ways to improve consumer trust can be seen in everyday life. These businesses have voluntary self-binding standards, they make partnerships with governmentally important organizations, and even use third-party labels for their product and innovations. This *transformational sustainability marketing* can be understood as active participation in public and political processes that favor sustainability intentions. (F.-M. Belz, 2001) Not everybody is ready or capable to pay these extra amounts for the environment. This raises questions about why consumers should, with limited capital, pay for these changes, when companies can make changes in their production, moreover, get support from greater actors, such as society.

## 2.2 Sustainable technology in culture

When companies want to make changes in consumers' minds, they also need to understand a few aspects. SDG is made by public operators and decision makers and their opinions might highly differ from citizens. At first, market and consumer behavior are different between consumer generations (Baby Boomers, Generations X, Y, Z), and the same solutions may not work for everyone. Secondly, they have to know the level of acceptance of SDG targets and social awareness about them. Third they should consider the overall attitudes towards the changes and values because they might differ radically between areas and countries. (Maciejewski & Lesznik, 2022) They predicted that by 2030 the target values from 2015 will be attained only for 53.8% of the national variables. In African countries, these values will be even lower. Therefore, decisive, and effective actions are required, both at the level of political and business elites and at the level of the individuals, the people who make up society. Effective information campaigns and regulations can only be carried out after identifying existing information gaps that normal individuals are lacking. After people recognize SDGs as legitimate goals and accept them as their own, the public sector should be provided with knowledge and equipped with the necessary competencies for the implementation of the SDGs, that are coming from the EU. Maciejewski & Lesznik (2022) created a model of four steps that need to be followed to achieve sustainable consumer behavior. Step one is about raising awareness of the existence and validity of SDG targets at the level of individuals. The second step is gaining acceptance and understanding from the individuals. The step requires a deeper understanding from the citizens since it results in the acquisition of competencies on how to effectively implement SDGs by the individual. Finally in the last step Engaging the individual's sustainable behavior to achieve SDGs, especially in the area of sustainable consumption.

Attitudes towards sustainability vary between generations, but they also vary depending on the country. When looking at Businesswires research (2021) on consumers who have either made significant changes to their purchasing behavior or completely changed their way of living to be more sustainable, Austria leads the way (42 percent), followed by Italy (41%), Spain (35%) and Germany (34%). For the US, 22% of consumers indicate major changes to their behavior, but that number jumps to 55% when including those who say they have at least made some modest changes. Some changes have occurred based on the survey, but changing the attitudes requires sometimes more. Being informative about the origins of the product and being transparent about manufacturing and production steps are becoming great methods to gain consumers' trust. In the survey made in the US, almost 80% of retailers and business owners believe their sustainability efforts pay off in increased customer loyalty. From the survey participants, 50 % of consumers showed their concerns and interests about sustainability are related to their concerns about the planet and change towards greener change, which has led to a situation where 54 percent of consumers read about a brand's sustainability initiatives and processes. Participants also mention that they have faced thousands of companies making green products, but are the companies making these products operating in a green and sustainable manner? Or is it just green marketing? This is something consumers now want to know. Similar research for our topic, sustainable understanding, and digital products development, has been made in Poland and the UK. In the research made in the UK (Archer et al., 2022), the primary reasons for not adopting a more sustainable lifestyle are related to cost (52%), lack of interest in the issue of sustainability (51%), and not having enough information (48%). This is leading to a situation where change is limited. These barriers are closely related to consumers believing that adopting a more sustainable lifestyle makes no difference and that it is too difficult or not available to them. This kind of consuming habit might be the result of an overwhelming amount of information in media, which can be felt shallowly in each individual's life. Nearly one in two respondents (57%) cited it as the main area to address. According to Archer et al. (2022), change in behavior and requirements for companies have changed, but one in two consumers either do not know what commitments businesses and organizations have made that they can trust or simply do not trust businesses on climate change

and sustainability issues. The need for development was mainly seen in products and consumption options and affordability.

Like mentioned before, peoples' behavior and perspectives are almost directly related to their geographical location. People might not support society's changes when they are not affecting them that strongly. (Kadry, 2021) Kadry states in his research that one of the biggest problems and the EU's challenge is increasing the popularity of public transportation in dispersed settlements. When distances are long, private driving is seemed to be more comfortable than public services, because of its randomness and lacking usability. In the cities, where trains and trams are running frequently, it is believed to be more natural and wiser to use these solutions, but not in the countryside. This can be seen as a strong unwillingness to use public transportation which also reflects the development of the services in certain areas. Different solutions are mentioned several times in the essays. Encouraging people to ride-sharing and co-owned vehicles will directly affect individuals' carbon footprint and supporting these solutions will come much cheaper for the government. Some surveys say that 96% of car owners said they think they will own a car in the future, the growing adoption of shared mobility services provides an opportunity to complement, rather than replace, privately-owned vehicles. Considering that the typical car is parked and idle for 95% of its lifetime the change might not surprise. (Kadry, 2021)

Sustainable development is touching everyone in the world, but different locations in the globe, or even inside a single country, are dividing values and perspectives. Another great divider is the people between the dispersed settlements and cities. Finland is a highly developed country where environmental issues are often heard and discussed in the media. But if we compare it to other European countries, differences in actions and sustainable development requirements are seen differently. Research made in Poland (Maciejewski & Lesznik, 2022) proves that only 27.8% of total respondents have heard the idea of sustainability, but the youngest under 24 years of age, have dealt with this issue most often. Western product and service-based markets were not that strongly thought of as a need for change. Important development areas were seen around poverty, energy solutions, and available food and water. Even though we are living in a capitalist world where consumption trends and vulnerability to social media influencers are high actors, production, consumption, and industries were not known that well, compared to Finland where development areas are focusing on technology and production. Perhaps also due to the exposure to the concept of sustainable development in the lifelong learning cycle and social media.

Mobile applications offer-limited possibilities to affect individuals' minds and emotions. People are using more and more social media platforms such as Instagram and TikTok and it has led to a point where more than 4.59 billion people actively use social media (Geysler, 2023). Social media and other applications have allowed a new kind of career to be possible and with that I mean influencers. Influencers can be single persons, groups, or organizations that are actively posting and participating on social media and with persons' followers. Even though people's behavior has been considered rigid, an influencer has the power to affect the purchasing decision of others because of their authority, knowledge, position, or with relationships with the audience. The importance of brands and their relationships with influencers has been increasing. According to the Digital Marketing Institute, 49% of consumers depend on influencers' opinions before making a purchase. (Wholey, 2022)

We can tell that influencers create meaningful relationships with their audience, which leads consumers to look toward them for opinions on products because they trust them. With the use of social media on the rise, when brands decide to use influencers' voices and channels, they are creating brand awareness about their sustainability action. As a downside, decision-making is left to influencers to decide and research the truthful advertising of the companies that they are cooperating with. Channel owners are facing a situation when they have to decide between benefits and sustainability purposes. According to other research made (Sertdurak, 2020), 86% of consumers are more likely to trust a company that reports its sustainability results. 82% say they are more likely to

purchase a product that demonstrates the results of the company's social responsibility actions and goals than one that does not.

## 2.3 Affecting behavior through technology design

Digital products have influenced human behavior for a long time, and they have initiated many new research areas and innovations. Many companies are following *Green Strategy Models* which can be understood as a service that provides decision-makers with the information for situations where data is needed for deciding green strategies and eventually how to align with them in business strategies. (Olson, 2008)

Another method, persuasive technology is a technology that is designed to change the attitudes or behaviors of the users through persuasion and social influence. Computers and mobile applications were not initially designed for persuasive actions since computer solutions were created for data handling and calculating. It was seen as a tool. In the last decades, computers have migrated their way into everyday life and become more persuasive by design and experience. Computers have taken roles as influencers where people can get help and the role of the computer is seen as a teacher, clergy, and even doctor, among many others. We have entered an era of persuasive technology, where interactive computing systems are designed to change people's attitudes and behaviors. (Fogg, 2002)

The earliest signs of persuasive technology were seen in the decades of 1970 and 1980. At that time, few systems were created for promoting health and that way increasing workplace productivity. The earliest example was BARN (Body Awareness Resource Network) which was developed in the late 1970s. The main objectives were to teach about the adverse effects of different health issues like smoking, drugs, lack of exercise, and many more. Its ultimate focus was to enhance behaviors in these areas (Bosworth et al., 1981) Gradually other interactive programs followed, focusing, on designing adolescent health issues or treating psychological disorders. But when it came to the late 1990s, the emergence of the Internet exploded its popularity and created persuasive technology.

Persuasive games have been used for conveying various persuasion messages and purposes for a long time (Ferrara, 2013). Many applications are mainly used for entertainment purposes only, but many are aiming towards a better future, trying to impact everyday life habits. Some games are mainly created for non-amusement purposes, meanwhile, persuasive games are more specifically concerned with persuasion purposes to change knowledge, beliefs, or attitude. In this case, this kind of game particularly conveys persuasion goals to promote environmental issues, promoting more sustainable habits. Gamification and trending products around greener solutions have become a trend and it can be seen in the strategies of organizations. (Ferrara, 2013)

Quickly after the explosion of the Internet's popularity, mobile phone producers noticed possibilities that mobile phones can offer, instead only for calling, texting, and simple browsing. Phones started to provide a great variety of applications for users' needs and with the rapid development years, the amount of mobile app downloads continues to increase every year, from 140.6 billion in 2016 to 218 billion in the year 2020, maintaining an 83% increase in five years. With over 3.2 billion smartphone users and 1.14 billion tablet users worldwide, we can tell that mobile phones have a great impact and influence on users since the majority of their time is spent with the application. (GoodBarber, 2021) Studies show that 88% of the time is spent on applications when using the phone. Applications have become a natural part of our mobile phone usage. We download and use apps for everything, from tracking our sleep to ordering a meal for delivery, not forgetting business and support services. We use them at home and work, when we are outside, during commutes and transportation, and even while eating or exercising. Essentially, apps have become an extension of ourselves. Increase of the popularity of social media is increasing the usage time every day and according to studies (GoodBarber, 2021), the average smartphone user spends around three hours and 10 minutes daily on their mobile device.

Mobile technologies and services have been in the turning point for the last decade. Almost all services for normal consumers can be found from the phone as an application. Google Play Store for Android and App Store for Apple products are offering almost 3 million apps worldwide such as services for banking, food delivery and for other everyday life situation. It is not only for purchases and playing, but nowadays data centered world is offering services to follow your electric consumptions and carbon footprint. One strategy of changing user and consumer behavior towards sustainable way is *gamifications*. Gamification is the use of gaming elements within non-gaming contexts to influence real-world behavior. Gamified programs and applications take the features of games that keep players' attention, like points, badges, leaderboards, and challenges, and apply them to real-world situations that otherwise might seem mundane or boring to increase engagement (Deterding et al., 2011). These gaming building blocks are used to engage users, solve problems, and drive specific behaviors. Gamification is increasingly popular and can be used in lots of different contexts, such as education, health, or business settings. Many companies have introduced gamified schemes to increase customer or employee engagement with great success (Deterding et al., 2011). Consumers are seen as major element when it comes to creating well-structured and organized sustainable economy. Companies and political parts are guiding towards better solutions, but final decision is always in consumers' hand. People are spending more and more time with their phones so planned marketing and greener design solutions are considered as possibility to acknowledge people with alternatives and more sustainable decision making.

Smartphones have become a tool for performing and controlling everyday tasks and needs. Smartphones and mobile devices are shaping users' life cycles by adding dimensions to the concept of socializing, performing actions, and even forming new habits. (Oulasvirta & Ma, 2012) Smartphones have become the most important platform for changing human behavior. New kinds of creations are giving new ways to hence creating opportunities to advance healthier and more sustainable lifestyles. Consolvo et al. (2009) state: "Technology designers need to recognize that lifestyle behavior change is a long-term endeavor that pervades everyday life, including the social world. If done poorly, the technology is likely to be abandoned; therefore, a principled approach for its design is needed." Mobile phones and their services provide a lot of information and possibilities. Now, organizations can affect consumers straight, even though consumers are relaxing in their living rooms. Mobile phones have also become a significant marketplace for companies. Rheude (2021) states in his research that almost 80% of smartphone owners in the USA have made a purchase on their phone in the last six months (data from 2020).

Mobile phone applications and social media might be motivated and often incentivized (through product and brand endorsement) to increase their power and persuasion on social media and many are becoming more proficient in attracting and engaging followers. Followers can be easily attached and obsessed, so their behavior can often become excessive and unhealthy. (Farivar et al., 2022) Many organizations want to participate with their customers in their daily activities, mainly collecting data from them but also want their products to become a norm in everyday life. The results from the research showed that when followers develop attachments both to influencers and their community (sense of belonging), this can lead to problematic engagement, even an addiction. People tend to get a feeling of belonging and that feel trust and safety. As a possibility, influencers can freely talk about the issue of problematic engagement and show care for their followers' well-being. Problems are not limited to social media platforms only, but they tend to occur in any application possible. It is also called as *Dark Pattern* of the phone application industry, which is defined as a user interface which has been carefully planned and crafted to trick users to do actions that they might not normally do. These tricks or effects on behavior are not accidents but carefully planned by designers who have a great understanding of human psychology. (Bringul, 2021) And as an aspect, the application does not always have users' benefits and interests in mind, but oppositely application owners want to earn something. These mind-affecting strategies and easy-to-use platforms have led to phone addiction. In Techjurys research (Georgiev, 2023) is proved that average smartphone owner unlocks their phone 150 times a day, leading to some sort of conclusion that 66% of the world's population shows signs

of nomophobia (addiction to mobile phones). This has led to a whole new industry where especially the mobile game industry has been forced to move towards monetization strategies. This means that even though the product is free, add-ons and needed services might be with the costs. In practice, this means turning things into revenue-generating activities, services, or assets.

The habits of consumers are often driven by three themes. The first one is about needs and wants: what kind of value this digital product can give me or why I need this particular product. Unfortunately, consumption is closely linked to each person's identity as a modern individual, which might not have anything to do with the needs or value of the product (Douglass & Isherwood, 1979). That is recognized as a problem in wealthier societies, where over-consuming is way beyond the level of necessity. The second theme is about the tension between rational consumer behavior and routine-habit-based models. Research has proved, that role of information is changing individuals' attitudes and consequently, behavior when it comes to sustainability, but there are adverse effects. Consumers' attitudes might affect achieving the wanted outcome. If a person believes that he/she is unable to adapt to the behavior or digital service, they are unlikely to even try. These consumer actions can be explained by attitudes towards the wanted behavior or just user norms (Ajzen and Fishbein, 1980). The third one is about affection and how consumers make purchases based on political or ethical reasons. This is a relatively new manner of approach since in modern societies, individuals can make their own decisions with much greater independence from traditional norms or social structures. (Giddens, 2020)

## 2.4 Sustainable design in practice

Becker et al. (2015) have created a model with three dimensions of sustainability, which should be remembered when creating sustainable applications and software. These three aspects will give a light guideline to developers on how to improve the value of user experience, which might become a part of persuasive behavior: *socio-centric concerns*, *techno-centric concerns*, and *eco-centric concerns*. The first one, the socio-centric concern, is focusing to question: how we can make people's lives better? That is usually the main element of the software, the reason why consumers purchase the product in the first place. Reason can be support for a healthy life to just handling everyday life tasks.

The second, techno-centric concern reflects software qualities and what kind of value it creates. The origin of the techno-centrism concept comes from the technology's ability to control and protect the environment. It argues that technology has an impact on ecological problem-solving ability and efficiency, and it can have an effect on outcomes from a managerial position. Theory understands human control over nature, but it takes environmental risks and problems to negotiate. It might not be the most nature-saving aspect, but it follows rational and scientific means, such as technological research. It sees the solutions for environmental problems, but not sacrificing technological advancements to achieve them. (Mason, 2012) The last one, eco-centric concern, is processing the environmental economy as a key element in sustainable development. Ecocentrism believes in nature-centered design, instead of human-centered. Originally it has ethical and political sides, but both of them seek to protect and improve the quality of nature from harmful human creations and actions. Nowadays, this method of environmentalism claims that the natural environment deserves whole consideration, demoting economic, social, and political aspects. (Milstein & Castro-Sotomayor, 2020)

The world has changed dramatically with technology development and computer technology has a growing influence on our lives. Services indeed make consumers' life easier, and digital services strain the recourses of society less. However, the increasing development and the need for digital products have many sustainability problems. This problem occurs during the whole life cycle of the product, hence affecting each consumer's carbon footprint dramatically. Considering the problem from an eco-centric perspective, the problem begins with the production of the machines and devices: energy consumption is humongous when we follow the product life cycle and its required



infrastructure to the end-user. (Frick, 2016) Battery technology, even nowadays, depends on limited resources to work properly. Lithium batteries are an example of this and are widely used around the globe. The problem occurs in the situation when a battery is not usable anymore, because they are not designed to be returned to a sustainable cycle after its life cycle. (Franquesa et al., 2016) If we think consumption problem from a socio-centric perspective (Becker et al., 2015), the key elements are digital products and their services' easy usability, accessibility, and inclusiveness. Application and online services are made easy to use and terms for consumption take less effort. From the socio-centric point of view, modern digital products are often addictive and have serious side effects on mental health. (Gray et al., 2018) are considering digital products as influential, where constant notifications and e-commerce are encouraging unsustainable consumption and unreasonable decision-making. For example: worldwide, eCommerce growth has been even more striking. Since 2010, global eCommerce sales have increased by nearly 800%. (Rheude, 2021)

In 2007, Blevis introduced (Blevis, 2007) us the concept of Sustainable Interaction Design (SID). It is a countermovement to the side effects caused by digital services and products. Technology and users are considered as a part of the solution for a better outcome, not only as part of the problem. SID is taking under processing the idea, that service design can be a part of decision-making and give information about choices that can lead to better, sustainable outcomes. Digital product has changed to affect environmental, public health, social, and even society aspects. This research field is considered to develop methods as reflective approaches and support consumers to make better decisions. Other considerations of SID are user behaviors and consumption, increasing awareness of SID in general, the sustainable use of materials, the transparency of information about the resource consumption of computerized systems, and more sustainable use of technologies. (DiSalvo et al., 2010) As we can see later in this thesis, consumer habits have an incredibly big effect on a sustainable economy, and they have keys to effect also to methods at organizational and business approach levels.

Even though SID has been a part of research and has been widely recognized, some research has criticized that its outcome has too little impact. (Knowles et al., 2014) Research communities have focused mainly on society-level solutions, and lack the social problems and environmental problems, principally climate change questions. It is stated that SID should be actively internalized to innovation development and technology-supported activism, because of its potential as an effective crowdsourcing method, which can offer solutions and share information about occurring problems. UX practitioners have also criticized the lack of actively participating in sustainable user experience design in their projects and daily tasks. (O'Connor, 2020) It should not be considered a part of the problem, but it should be considered as part of the solution and organizations should build methods around it to support these better outcomes.

There is often a gap between practitioners, researchers, and UX design professionals. It is sometimes hard to combine theories and design and wanted theoretically proven methods are sometimes carried out incorrectly. (Goodman, 2011) To counteract this problem, Goodman has created three aspects to consider before the actual execution of wanted changes in the product. Depending on the service and audience, certain rules are to be followed. The first one is to identify the audience: there might be certain obstacles due to experiences and levels of interest in a sustainable topic itself. The second challenge is to find a suitable design process: how to approach the design task? If there is a theoretical framework behind the work, how it can be fitted to the work process? The last challenge is communication. How to create the design to match the media and already practiced methods. This includes the communication between the product providers, between designer and executioners, and also the outcome with the consumers.

### 3. Methodology

In this chapter, the data and research methods are presented. The data consists of students essays from a university course. We did not ask for personal information, but we know that the majority of the university students are between the age of 20-30 years old, and because the Finnish system provides open university education to anyone, some of the participants can be older. Students are currently living and studying in Oulu which is in the northern part of Finland. They have a northern point of view about services and sustainability, even though COVID-19 allowed remote studies during the year, leading to few students living in southern parts of Finland temporarily. The course was held in Finnish and the majority of the students are enrolled into bachelor's degree study programs. A small part of them is currently working in the IT industry and many of them as part-time. Overall, most of them have experience from working, but also from different technologies and electronics. 163 essays are collected, and data is gathered for qualitative analysis providing data analysis from decisions and opinions. This collected data is further used for nexus analysis, to understand how and which actors have influenced the way of thinking about a green and sustainable future, and how the students see themselves in a journey towards the common targets, of a strong and sustainable society and economy.

#### 3.1 About the material given to students

Collected essays were part of a business-related university course and done as a weekly assignment. This university course is available to any students who are enrolled in degree programs, but also, an open university class where anyone interested can join. The world is changing rapidly and people's consumption habits and action with it. Students' points of view are used for understanding a current mindset towards the European Green Deal and also, what kind of technological innovations are used to achieve a sustainable world. These essays were collected during the 2021-2022 academic year and represent the views of Information Processing Science students that are in the degree program which includes subjects of Information Systems, Software Engineering, and Computer Science.

Students were introduced to and familiarized with the EU's program named The European Green Deal. This ambitious program is aiming for more sustainable development and neutral climate change. Not only as environmental status but what opportunities this program can enable for the massive and connected economical regions. These methods and targets are listed in European Commission's Announcement 2019. The EU lists eight essential targets for the following years: (1.) Fresh air, clean water, healthy soil, and biodiversity, (2.) Energy efficiency by repairing buildings, (3.) Healthy and reasonable food prices, (4.) Increasing public transportation solutions, (5.) Clean energy and high-end clean technology innovations, (6.) Long-lasting products that can be repaired, recycled, and re-used, (7.) Future jobs and education for the transition period, (8.) Competitiveness and survival of global industries. (European Commission, 2019) The European Green deal's goal is to protect, take care of and increase the natural capital around the EU and improve their citizen health by protecting them from environmental risks and effects. The topic was also brought closer to normal consumers by giving examples from Finland, especially from Oulu and Tampere universities. These were used to give aspects to think about before answering certain questions in their essays. Material from the University of Oulu was focusing on social sustainability from *GenZ's* point of view and how digitalization is or will be affecting people. Lecture material from the University of Tampere was focused on technology business in the circular economy and climate change.

## 3.2 Student assignment

Students were presented the following questions in the assignment:

- *What European Unions' target were seen important?*
- *Does technology and its new innovation affect or have a meaning to sustainable development?*
- *What sustainable innovation do students want to be solving in the future?*
- *What technologies are mentioned to have meaning towards greener future?*
- *Do consumptions habits affect the achievement of EUs' targets?*
- *Who can make a difference and how?*
- *What possibilities and challenges does the future offer?*

The task in this weekly assignment was to envision the future through software innovations and how it might help (or not) with the EU's targets. Students had to choose at least three (3) from the previously mentioned target list and consider the future within chosen sectors. With the help of the given questions, they wrote their essays. Are these sectors touching individuals, bigger organizations, or the whole society? Will there be distinct benefits or problems? What kind of problems would you like to be solving in the future? How and in which role do you see yourself when solving these problems? What kind of values have arisen and who especially are benefitting from it? Will there be new kinds of innovations and businesses? The essay should be 600-900 words long and students were given free hands to innovate future technologies and visions from the greener world.

## 3.3 Data collection from the essays

Students were asked for permission to use their essays for research purposes. They were informed how the data from the assignment would be utilized anonymously for research. Students were also told that their choice to give consent would not affect their grade in the course. Of the 183 participating students, 163 (89%) gave permission to use their essay as research data. Gained results from the essays were compiled to Microsoft Excel – table before deeper analysis. Essays were written in Finnish and translated to English for the usage in this thesis. Results were divided to ten different sections.

Data gained from the essays were inserted either as keywords for data analysis or as open sentences for deeper analysis and understanding. For some sections, students could pick up topics from earlier mentioned targets of the EU that did not require deeper analysis. These students' essays and answers were then used as a base for nexus analysis, which is explained in the next section. Overall, the analysis is a combination of qualitative and quantitative methods. Quantitative data is used for understanding the topic and as a manner of approach towards deeper qualitative understanding.

There are ten tables: six are introduced and shown in this chapter and the other 4 are added as appendices 1,2,3 and 4. Material analysis is composed of the 163 essays that were done as a part of the course. The analysis is made with two different methods. The first one is pure data and points added to tables with different sectors. This gives quantitative material about essays overall and helps to recognize distinct differences and main points. Other methods used are Nexus analysis which is trying to find complex relations between discourse and action. Actions can be inherently social and mediated, so social actors are playing a part in habits and actions.

## 3.4 Nexus analysis

Scollon & Scollon (2004) describe nexus analysis as an ethnographic methodological strategy, which is both discourse analysis and motive analysis. It aims to change the nexus of practice and consists of three tasks or activities, called engaging the nexus of practice, navigating the nexus of practice, and changing the nexus of practice. There are many concepts in nexus analysis. *Social action* refers to

any activity conducted by an individual and has reference to social networks that might have influenced certain actions. In the context of nexus analysis, any action is inherently social and carried out using mediational means. Those represent cultural or psychological tools, such as a joystick or the English alphabet. *Historical body* refers to the bodily memories in an individual, also known as personal habits; the same role can be performed differently depending on the individual's history of personal experiences. In this thesis, the majority of the students were sharing the same current educational phase of education, and everyone was living in Finland, speaking the language. The historical body combines goals and purposes, life experiences, and physical conditions. *Interaction order* describes the different roles and role expectations in the situation. The other people in the situation influence the behavior of the person. The behavior might differ depending on whether the person is alone, in a group, or who they are with not forgetting what kind of rules and laws they are living under. For example, behavior while chatting with friends might differ compared to when talking with a medical doctor. *Discourses in place* include diverse kinds of discourses, which circulate at different speeds. Slower discourses could be the aging of the built environment, and faster discourses are the conversational topics among friends. (Scollon & Scollon, 2004)

Nexus analysis by Scollon & Scollon (2004) was applied to gain a thorough understanding of the topic of the data. The analysis is conducted from the ethnographic content, discourse analysis, and motive analysis. This can be simplified to form: what is said, how, and why? The sequence starts with engaging, after which the actions of navigating are taken, and finally, the change. (Scollon & Scollon, 2004.) This thesis uses data analysis and quantitative methods too for exploring the current research, but also when inquiring and exploring the students' thoughts on sustainable technology development and use. From the phase of navigating the nexus of practice, this thesis will introduce all three core concepts. Discourses in place, historical body, and interaction order were applied to analyze the topic more profoundly. The data gathered from the essays were analyzed by focusing on those three concepts which are composing social actions related to sustainability technology development. In the final phase, changing the nexus of practice, I will put together data-analysis results and find the reason behind the current thinking and answers.

The process started with engaging by exploring current research made on sustainable technology development and its factors. Within the study setting, this meant exploring previous studies and analyzing student essays about sustainable development. Engaging in the phenomena through existing research of different publications that included mostly scientific articles, newspaper articles, reports, and surveys from Finnish and foreign authorities. In addition, because the pandemic and the actions taken to prevent it were still occurring during the time essays were written, I will use it as an actor a bit. Navigating in this study was inquiring and exploring the thoughts on sustainable technology development and use in the student essays. The data analysis started with the previously described Excel document. The questions in the document were constructed based on the previously mentioned historical body, discourses in place, and interaction order. These results will be part of the discussion on sustainable technology development and its effective factors because they tend to affect individuals' own actions and change.

## 4. Analysis and Results

In this chapter, I present an overview of the results. This first section shows the results in quantitative form about students' opinions and decisions made. After this, I am taking collected data under deeper analysis with nexus analysis, to understand the historical body, discourses in place and interaction orders.

### 4.1 Quantitative analysis of the essays

The first task of the students was to pick three of the EU's targets for their essay's discussion. In Table 1 the eight targets are represented as in the original student's assignment.

**Table 1.** List of European Unions' targets.

(1) Fresh air, clean water, healthy soil, and biodiversity
(2) Energy efficiency by repairing buildings
(3) Healthy reasonable food prices
(4) Increasing public transportation solutions
(5) Clean energy and high-end clean technology innovations
(6) Long-lasting products
(7) Future jobs and education for transition period
(8) Competitiveness and surviving of global industries

Targets that were chosen by the students are listed in Table 2. The numbers in the second column represent the amount that different targets were selected. The targets are sorted by their popularity in the essays among the students. As we can see, top three of the targets distinctly gaining more picks than the rest and last six targets were similar in popularity order.

**Table 2.** What given European Unions' target were found important by participated students.

(6) Long-lasting products	106
(4) Increasing public transportation solutions	87
(5) Clean energy and high-end clean technology innovations	72
(1) Fresh air, clean water, healthy soil, and biodiversity	52
(7) Future jobs and education for transition period	45
(3) Healthy reasonable food prices	44
(2) Energy efficiency by repairing buildings	44
(8) Competitiveness and surviving of global industries	36

Every student had to choose three targets from the EU's list that they feel that might have the most impact to achieving the targets. Five of the targets were having the same number of choices, but three of the listed targets gained clearly more choices than others. These targets were (6.) Long-lasting products that can be repaired, recycled, and re-used (106 times), (4.) Increasing public transportation solutions (87 times) and (5.) Clean energy and high-end clean technology innovations (72 times).

Reasons for favoring these topics can be that these parts are strongly related to writers' current events in life. The level of knowledge about electronic devices is relatively high in the current society, so the topic seemed to be familiar to the students who wrote these essays, but also, public transportation is widely used by Finnish students. That could be seen in a majority of the texts. Long-lasting products were a popular topic in the electronic-related news when mega brands are pointed out about making products too weak or making money with repairing services and with any additional parts and accessories. Not only because of its significant influence on nowadays consumers' habits and consumptions, but it seemed to be a relatively light and casual topic to discuss in essays without any mandatory background research.

The second most popular choice among students was increasing public transportation. The topic is interesting since the geographical location from where the essays are collected, North Ostrobothnia, public transportation is not as developed as in southern Finland. Some of the students mentioned being from the South, but the amount was not notable. Based on the data gathered, a typical Finnish student seemed not to drive a car so public transportation is a close topic in everyday life. In northern parts of Finland, it is still more common to drive a car if you have one, than take a bus or a train, and it was strongly highlighted in the essays. The most common reason seemed to be disjointedness and impracticality. Development of the public transportation is strongly seen as necessary by the students if the EU wants to achieve its goals in this section.

The third most common topic among students was clean energy and its high-end innovation. Clean energy seemed to be a known topic in Finland since the development of wind power, solar power, and other clean solutions. Different energy technologies use different natural resources in various ways, so their economic, social, and environmental impacts vary, depending on geological location. Students believe that markets have offerings for consumers, but the social acceptability of renewable energy technology sometimes needs understanding and changes of traditional methods and expenses. After all, it is commonly reflected in climate change issues (Batel et al., 2013). Also, the topic was highly related to the field in Information Processing Science, the programme where the course was held. Bachelor's degree students are familiar with software business and its innovation so this was a previously known topic, which might have affected to popularity and ranking of listed targets.

Technology and its innovation are generally seen as a key element in a process towards sustainable development and the environment. Students were asked to analyze and give thoughts about technology's role in their vision of the near future and understanding. Mainly technology and its innovation were seen playing a major role when talking about achieving the targets. As we can see in the Table 3, while 74% of the students acknowledged the role of technology, almost 20% thought that it will not intrinsically have the ultimate role when it comes to changing the world towards green thinking. Other factors that were seen strongly playing a part were a change in consumer habits and political authors. Change towards a greener world seemed to be ready in the technology sector but it is not widely enough used and executed. 6% of the students were thinking that technology is not playing any kind of part when it comes to a green future.

**Table 3.** Is technology and its innovations solution/highly related to sustainable development?

Yes	121	74 %
Neutral	32	20 %
No	10	6 %

Students were given a chance to envision themselves as a part of the green change projects. From the eight listed the EU's targets they could choose one target they would like to pursue and what they want to be involved in. Students' topics were similar to previously made decisions. Results are listed

in the Table 4. The top three targets were once again (6.) Long-lasting products that can be repaired, recycled, and re-used (53 times), (4.) Increasing public transportation solutions (32 times) and (5.) Clean energy and high-end clean technology innovations (26 times). The rest five were once again at almost the same points. If we compare to previous research (Maciejewski & Lesznik, 2022) where high-valued targets were about human rights and food and nature, Finnish students tend to choose something that directly affects them. These directly affecting topics are usually developed in a shallow way and non-technology strategies are common. Even though Information Processing Science is focused on software planning and programming, many decided or wanted to be in a leader or administrative position. Green thinking and the EU's target were not seen as interesting as programming jobs. A lot of new ideas were found, and even properly planned visions were introduced in the essays.

**Table 4.** What problem would you like to solve?

(6) Long-lasting products	<b>53</b>
(4) Increasing public transportation solutions	<b>32</b>
(5) Clean energy and high-end clean technology innovations	<b>26</b>
(8) Competitiveness and surviving of global industries	11
(3) Healthy and reasonable food prices	10
(1) Fresh air, clean water, healthy soil, and biodiversity	10
(7) Future jobs and education for transition period	8
(7) Energy efficiency by repairing buildings	8

In the next question, students were instructed to visualize future technologies that will help with achieving the targets. Innovations need not be whole new ideas, but the student's mission was to consider which exact technologies are helping in this task. The list of technologies would be long, so it was simplified by grouping different sectors in Table 5. Inventing something new seemed to be most challenging so students focused generally on ideas of increasing the usage of already existing technologies and products.

Of the 22 technologies listed in the Table 5, five seemed to be over the others by the students: Electric cars and other vehicles (electric scooters), Solar power and solar panels, Wind power, Artificial Intelligence, and Mobile technologies and services. Electric cars and other vehicles as the number one solution was expected, because of their activity and prevalence in news and forums. Participants have noticed that Finland is moving towards electric cars by raising the gasoline and diesel-based cars taxes and increasing the possibilities and charging points for electric cars. Many students understand that the state has arranged regulations where housing cooperatives are required to organize electric charging points in parking lots. That makes it easier for typical consumers to consider buying an electric car without thinking about where to charge it. Also, Tesla is strongly influencing the development of electric cars and providing green energy solutions for every driving and other innovation globally. Students also supported the electric charging point rate and locations all around the world.

Alternative energy solutions were strongly represented in the future technology part of the essays. Many students think that solar and wind power solutions are key to success with a greener future, but there are some exceptions. In Appendix 1 we can see that trust in current alternative energy solutions has not reached its peak that people might automatically choose them as the only energy source. These sources are still seen as weak and expensive for their wide usage. Students also highlighted that people are looking for environment-friendly solutions yet cheaper or at the same price. They also mentioned

that environmental thinking is facing challenges in Finland during the energy crisis. Wholesale prices of electricity and gas have surged as much as 15-fold since early 2021, with severe effects on households and businesses.

Artificial intelligence (AI) has been developing strongly in the last few years. Based on the appendix 2, many students think of it as a product that will replace humans when it comes to operative work. As I saw from the students' essays, a majority who spoke out about future jobs and education were stating that humans work positions will be changed radically in the future. This can be seen in essays as understanding the situation of low-educated workers, especially when they are doing operative work, and when their tasks can be replaced by automation. Students understand that it is right thing to happen because artificial intelligence is also seen as an improvement. In the essays, students think that efficiency, monitoring, and production in the different industries are developing if financing and effort are given to these specific technological solutions. Not only developed products are better, but students think that it will affect pricing, too. Based on the essays, the main reason that greener solutions are still lacking is the cost. High-end production devices, like using AI in optimization, can decrease production prices and that way expand the popularity of green or ethically proper products.

**Table 5.** Which technologies are mentioned as important factors in the future towards green and sustainable development?

<b>Electric cars and other vehicles (electric scooters)</b>	<b>62</b>
<b>Solar power / solar panels</b>	<b>42</b>
<b>Wind power</b>	<b>34</b>
<b>Artificial intelligence</b>	<b>31</b>
<b>Mobile technologies and services</b>	<b>23</b>
Telecommunications, antennas, and sensors (IoT)	22
Construction and production automation	21
Robotics	20
Self-driving vehicles	17
Remote-work and online school services	15
Nuclear Power	14
Home electronics and smart houses	13
Delivery services	10
Waterpower	10
Web services and stores	8
Food manufacturing and production devices	8
Smart electronics (watches, rings etc.)	7
VR / AR	5
Nature cleaning innovations	3
Nano technology	2
Food services / shopping	1
Cloud services	1



Results in the Table 6 are showing that students believe that consumption habits are considered to strongly affect the total consumption in the globe. People tend to be more and more informed about green technologies and ethically better solutions, but students in this sample mainly thought that green pricing is still too expensive, and it is not attractive as it should be. For example, unhealthy food is seen as more attractive by the students in some cases because of its price, in some cases healthy options in restaurants can be a half more expensive. Green products are often understood as premium products and because of that, many are thinking that forcing green laws and regulations too early will increase inequity. Students believe that controlled change in customer informing and improving awareness will be a great way to increase the probability of achieving the EU's targets. Strong trust in the future was active in the essays. Almost everyone believed that green products would reach their deserved popularity once alternative energy and production solutions are found. Food manufacturing will move to closer to laboratory food since the global population is growing all the time. Students mentioned that alternative nutrients are found, and food quality awareness will become a part of daily life among Finnish people. They believe consumer habits change within food and goods consuming, but with transportation too. Students strongly believe that it will challenge the companies in the future and as mentioned before, changing consumer habits will become one of the most important and relevant keys to success factor inside the companies.

**Table 6.** Do consumption habits play a major or direct role in achieving the goals of sustainable development? (Or is there a greater responsibility elsewhere, e.g., the state, companies.)

Yes	90
Neutral	32
No	41

Even though individuals are seen as a major group who can make difference about greener future, it was strongly expressed in the essays that responsibility lays in another place. The list in Table 7 is simplified from the original data collected (the original can be found from the appendixes in Appendix 3). From Table 7 we can see students' opinions about different stakeholder groups that are believed to influence consumer changes and have most power in sustainability change. The public system and government are seen as strong influencer because it can lead peoples' habits and operations by regulating laws and rules towards better future.

**Table 7.** Who can influence (stakeholders) and have most effect?

Public System / Government	111
Companies	73
Production / Factories	44
European Union	33
Individuals	11

## 4.2 Nexus analysis of data

Next, I make a deeper qualitative analysis on the reasons behind the current sustainability opinions and actions. First, I discuss about discourses in place, which means societal talking points, trends, organizations, and Finnish values. That will lead to analysis of the students' historical body, what in their background can be interpreted to affect their views and highlight themes emerging amongst our respondents. Finland is highly developed technology country, and that can have strong impact on

behavior together with students' personal history. Mostly they were students in the same university, living in similar life situation, but some students were enrolled in the open university rather than being regular students at university. At the end of this part, I focus on interaction order to understand who the students think is the actor who really has the power to influence these individuals. These analyzed aspects in this chapter are listed in the Table 9.

#### 4.2.1 Discourses in Place

Even though students have gained knowledge about sustainable energy and innovation options almost every day, there can be factors in the background. These discourses can be influenced by others, or it has been the person's principle for a long time, developed while growing up. Not every student discussed their background or factors behind the behavior, but many of them strongly highlighted it and in some cases, it could be read between the lines. I have divided these effective matters into four different categories: working history and education, society, transportation, and the last one, another commonly mentioned background factor, that was seen as important when it comes to habits and actions.

Discourses in an educational environment and at work have had a great influence on understanding sustainable development and methods of how a green future can be achievable with sustainable innovations. For example, students who have worked in deciding and management positions tend to think of sustainability through costs and expenses, similar to ones who studied economic studies. Universities are more interested in this kind of innovation and want to introduce the student to future possibilities. Also, students with work experience have noticed the changes within the organizations, and how the government and other actors are constantly offering and supporting better, greener options. The majority of the students were from IT-related degree programmes so they were generally wondering how software businesses can help and save environmental resources, which are present in their almost daily discussions. Discourses mentioned were about software developments with low direct straining on the environment. The biggest deviations were found in students from different degree programmes. Their daily environment and conversation led to gaining information about current innovations and technologies, which have a direct effect on their opinions about technology development. The ones that mentioned studying something other than Information Processing Science, seemed to have opinions modified around their major: economy students thought more about markets' welfare, and industrial students more about development areas of production. They were not crushing the climate change and EU's targets, but they highlighted that green change should be made concerning local economies and notice the differences between geographical locations. This topic raised in many essays too, but not that strongly. It can be said that this must have affected sustainable thinking for these students.

Students who mentioned studying industrial engineering, or similar, were focusing mostly on production solutions. Their discourses seemed to be around production-based change and its benefits and disadvantages, instead of environmental issues. They mostly think that change will start from the companies and factories. Students believe that green development will improve product efficiency, but also save consumers money. This is mostly seen reflected in construction and energy problems. In an essay, an industrial engineering and management student states:

*"The materials and technologies developed as a result of research and development by industrial enterprises are the key to more energy-efficient buildings. If, for example, the insulation of buildings can be improved with better materials, less energy will be spent on heating, and this will of course affect society as a whole. In Teoria, it can be thought that people will then have more room to choose." (E129)*

Students believe responsibility lays not within the average consumer even though human behavior can then be changed. They have a technical understanding and knowledge of how mega brands can

make a difference, believing that big changes will come in the future. On the other hand, students who study geography or were interested in biological matters were highlighting each person's responsibility. Discourses seemed to be around environmental and nature issues; thus, related to their background studies. Students mentioned that recycling, reusing, and saving natural resources, also including companies, should be assimilated into every-day life actions and habits. Even the small things matter in the big picture and only then EUs' green targets can be achieved. Another aspect was the change and development of digitalization toward social media-based entertainment. Trends are also seen by the participants as an outcome of changed behavior online because social media is taking a lot of time for consumers. One student mentioned the problem that has occurred and been talked about in his work:

*“At work, for example, we think a lot about how digitalization is seen narrowly, primarily as social media, forgetting about technology and other dimensions of digitalization. Of course, social media is today and still on the surface. In the understanding and definition of the digitalization of everyday and working life, the processing should be shifted to understanding digitality as a broader issue than social media, and the possibilities of technology should be considered more strongly in everyday life.” (E45)*

Some students had management and decision-making experience. It is a hard decision also for management when it comes to social and human leading positions. Green and sustainable future is now seen as a great achievements, but disadvantages are also seen, so quick and non-planned change is not supported. In one student essay (E164) EU and its target were criticized about its action and how it reflects on management:

*“Then comes the EU, which tells the company's management that you must do this and achieve this target in terms of emissions, or else your activities will be stopped. They concluded that such changes in the company would cost them 100 million euros. Then they came up with it: outsourced the manufacture of the company's products, even to China.”*

Prices and cost of change are well-known for students in these positions. The ideology is supported but readiness for massive changes is questioned, and that way might negatively affect sustainable thinking and decisions. Other positions that emerged from essays were taking part in housing cooperative decision-making. Green solutions were kept important, but pricing was thought to be still an important factors for decisions. There was a dividing line between work experience and its effectiveness. Students believe that software businesses have less efficiency in sustainability problem, instead, they believe that better communication between product and customers have to be released, since the changing power is believed to be in higher authorities. Also, the costs of the change seemed to be more known among the students and detailed when they have been in the decision-making processes. They know well the costs of renovating and meaningful changes, but it is still reflected in green decisions. They also mentioned that personal decisions can make a big difference, but major changes need to be more planned, other than forced by upper authorities.

Students commonly thought that society plays a big part in modifying and changing the consumer's mind. Freedom of speech and rights have changed the mental states of European consumers. Individuals can have their own opinions, choices, and actions toward the topics they are interested in. This was the leading opinion in students' essays, but students also know that the situation is not the same around the globe. Person rights are believed to originate from the EU's structure by the students. Still, there are differences in structural transitions if you compare Finland and southern European countries. Society is still sometimes controlling behavior or strongly affecting others behind the back, leading to a situation where individuals' mind ends up just following rules over rationality. On the other hand, modern European society follows capitalistic ideologies. Mega brands are thriving where wealth or capital goods are seen as important. But they are also said to chase only profits, leading to a downgrade of the quality, since they are aware of current market behaviors:

*“In a capitalist society like this, words like “long-term” seem to be swear words in many big businesses.” (E74)*

Students stated that it is directly reflected to consuming habits, which has been strongly emphasized in the essays. Also, modern digitalization has affected jobs, which is forcing individuals towards change. Old traditions in consuming are believed by the students to change and new trends are modifying markets with constantly innovated digital products. Like one of the students said in their essay:

*“However, I think it is mainly the companies to create better alternatives for the consumer, rather than the consumer demanding change from existing businesses.” (E75)*

Students mentioned another aspect that has been affecting individuals’ thinking, public services. Students seemed to have a lot of talk about society’s services and how it is lacking in some cases, leading to the conclusion that northern Finland’s citizen criticize the current level of services. Society is providing a wide variety of services that citizens can enjoy, but geographical differences mean challenges to give it equally to everyone. This is seen in the essays since the majority of writers were located in northern Finland. As mentioned before, public transportation was one of the most popular topics when it came to the European Green Deal. Green change in transportation and driving was seen as a great development area, but not many students were willingly decreasing their driving or giving away their cars, even though it means better for a green future. Not before greater changes. Few matters have affected this kind of thinking. The first one, freedom of moving around freely was a strong discussion and support by many students. Many students mentioned being from the town and areas, where busses were running once an hour and dealing with everyday tasks, was impossible with just local bus lines. It is a long-term accustoming to a situation where your car is considered a necessity. This is strongly considered as lacking resources in local sectors, typically in dispersed settlements. If changes are happening for the better, students are believing that number of users in public transportation might increase automatically without persuasions. Essay 139 says it shortly:

*“I also believe that the increased public transport will bring in new customers, as the current public transport does not offer a sufficiently comprehensive set of routes, let alone a timetable.” (E139)*

Another reason for cheering for private driving was its necessity in work and one had even made research about it, proving that public transportation is not working properly in his living area, in northern Finland. That is why the European Green Deal is seen as important, but not in reaching an important point where private driving is decreased. Generally, a discussion was around sustainability influencing behavior and change and the nature of electronic trends. A discussion was around social media because almost everyone uses it and it is commonly used as a communication channel, modifying people’s opinions and minds every day, which has also been covered in previous research. This can be felt as a problematic effect because the correctness of social media information is hard to guarantee, and it might lead to excessive consumption. Students state that mobile phone has increased their importance enormously and businesses can use opportunities with them by decreasing mileage, so the consumer has to purchase new ones once in a while. Even though these students see this as a problem in achieving the EUs’ targets, they are forced by the current market situation to make this consumptive behavior. This trend has been noticed by many students earlier when they were younger, leading to skill improvements with fixing these devices. This has led them to respect nature a little bit more, creating a paradigm where re-use-based development is the key to a sustainable future. Data from essays is providing the conclusion that pricing has also been considered to influence matters when it comes to thinking about green products. With the price, equality thinking came up a few times and it is mentioned to be the main value of their lives. These few students highlighted the idea of restrained change, since not everybody can afford major changes.

## 4.2.2 Historical Body

When we view the historical body of the students there are a lot of similarities. Some of the students were from the southern part of Finland, but they have now got accustomed to northern Finland's living conditions. These students were either studying as regular bachelor-level students at the University of Oulu or attending the course via an open university. Everyone is interested in IT and business-related studies and in this case, sustainable development for a greener future. Courses were held in Finnish, so everyone was capable of speaking and writing the same language. Origin countries for students could not be seen from the essays, but if you can master Finnish at the university level, one can tell that person is integrated well into society. Students are accustomed to Finnish culture and familiarized with Finnish society and regulations, and the majority are in the same life situation, studying bachelor studies at the University of Oulu, giving base to evaluate opinions equally. In Finland, everyone can study no matter the age, so some deflection was in age distribution, but the majority were between 20-30 years old. Many students tend to be interested in information technology and gain knowledge about computers. No mentions exactly of social groups or friends, so the social environment that came to our known was mainly through remote services, gaming, and workplace environment.

The majority told that they are from the northern part of Finland, so sampling from the bigger centers, Helsinki, etc., and knowledge from wider public transportation services are not included in their aspect of every-day life living. It gives perspective from northern areas and how green deals and caused changes are seen outside of busy European cities. Cultural differences might vary significantly. In southern Finland, public transport was trusted by students who mentioned it and it is felt as a typical norm in everyday life.

*"In cities, public transport usually operates in a businesslike manner, and in the Helsinki metropolitan area it is objectively the most convenient way to get around." (E43)*

Generally, few things were mentioned by the students that was occurring to green deal thinking and sustainable development. The most mentioned aspect was background and history from living in dispersed settlements. Changes in society and in public sector are not seen that important, since more every-day tasks are performed outside of public services. Students also know disadvantages of these areas and it has strong personal effect to person's point of view, because local culture has grown and have been close from the childhood. These thoughts are reflected to public transportation and its understanding.

*"Public transport does not yet work well enough in sparsely populated areas for people to want or be able to give up their own cars. In the metropolitan area, where the population is most concentrated, buses, subways and trams run in different directions every few minutes." (E137)*

Services that were used by the majority of students are public transportation, train services and other mobile phone applications for food delivery and using electric scooters to move around. There were experience from sustainable services but understanding the environmental benefits of those were sometimes lacking. Other services or applications that were mentioned to been used were about measuring and following electricity consumption, which has, according to students, become almost trend in last year because of energy crisis and other factors. Busses and other transportation methods offer limited possibilities to move since you have to follow a certain time schedule, but also you have to prepare to walk a bit in each end. Secondly, geographical position has influenced students' opinions a while. In southern Finland public transportation is running constantly and it covers a wide area offering options and flexibility for citizens. In this case, if you compare that to northern Finland, where bus lines are organized to follow just rush hours or otherwise running once an hour, flexibility is not really high.

Students who worked tend to have more to say about sustainability actions and costs, leading to conclusion that topic is somehow actively surfaced between coworkers. Experience from work were mainly IT related fields, but also from retail, bank, and constructions-based companies. Few students mentioned work experience from recycling procedures and grocery stores waste management. There they have to know which products are recyclable and same time they have gained knowledge how much products are going wasted in modern society.

*"I have seen how much the waste varies and how much of it is wasted. Of course, waste is used for subsidies and pigs, but energy is still wasted on transport and packaging." (E93)*

This has changed their point of view of a greener future, highlighting each student's decision-making. This is seen in their recycling habits and how they are supporting companies or products that are making their businesses more sustainable. Overall, coming to student life has changed the majority's minds and habits, since it usually is the first time, they start living by themselves, without parents. It has challenged students to make their own decision and how they want to be part of a green future since everything is in their hands and behind the effort. EU's Green Deal targets seem to affect many aspects of students' everyday life.

One mentioned factor that has affected students' way of thinking about green change is their position in the current company or organization. Working experience from training people and management, has shown the challenges of changing the working environment. Students mentioned that people are hard or challenging to re-educate in a new position, especially when a person has made operative work for a long time. They believe that many times, these people are replaced with robots or other automatically functioning devices.

### 4.2.3 Interaction Order

Students had many ideas for the future and for actors which can affect the sustainability of our future. These actors are listed as Appendix 3, but to help the discussion I have divided these actors under the five categories: the EU, the Public System, Companies, Production, and Individuals. Table 8 also answers the question that who can influence the markets and make changes in long term according to interaction orders mentioned in the student essays. These five actors are shown in the Table 8 which indicates how many times each type of actor was mentioned and discussed by the students. Public system, mainly society, were seen the strongest actor in the green change field, followed by the companies and manufacturing. The EU was mentioned to have responsibility over changes and planning, but individuals were not seen as responsible of green issues. Next, we will go through these five actor groups and discuss how they are seen to affect the EU's Green Deal and consumer habits, but also how it has influenced decision making.

**Table 8.** Actors identified in student essays.

European Union (33)	Companies (73)	Production / Factories (29)	Public system (111)	Individuals (11)
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Students highlighted that the public system has the power to make regulations and laws that citizens are got used to following. Society can be a prominent influencer in individuals' minds and behavior, its meaning has been balanced with mega trends and brand intentions. Students think that the EU should indent member countries and major companies and support these societies with transforming towards wanted green deal targets. This kind of collective climate politics will standardize methods and actions, leading to positions where citizens are acquiring new policies and changing their behavior for the better. The EU can also improve its attractiveness by spreading out know-how skills and education services around the globe. One way for that is to improve the availability of

commonweal knowledge among everyone. Since megatrends are seen as influencers in modern society, students believed that controlling the competition is considered a requirement to reach a common target, making clear interaction order between actors. If not by limiting competition, it can be made by forcing greener standardizations.

The EU might be an important factor in interaction order from students' point of view, but a more core actor seems to be public services and society. Even though individuals' actions are seen as the most important change in the greener future, responsibility is placed on society, since it is seen to be the society and higher decision maker's job. Collected data stated that public financing for the companies has to increase and domestic production and development levels have to be improved. This allows normal individuals to get greener options. To guarantee the possibilities with green change and the future, the students state that society must provide enough education opportunities for future job requirements since it has a great influence towards sustainable future development, but also it gives better opportunities for citizens' future careers. Citizens' knowledge and education can be improved by new digitalization learning and studying innovations and enabling lifelong learning. The majority of the students thought that educational level and opportunities are already of high quality, so everything cannot be left under society's responsibility:

*"I find it absurd to provide the necessary training during the transition of jobs. Demand always meets supply, and structural unemployment is temporary. I believe that people must be offered access to free education, as is the case, for example, in the Nordic countries, but it is not society's responsibility to provide transitional education. Companies must take care of the training and orientation of their own staff." (E13)*

Like mentioned before in the discourses section, green habits in transportation are society's responsibility and it should be enhanced and improved with availability hence giving the change for people outside of the cities to choose more sustainable public transportation. Other aspects students are mentioning are energy efficient building and comprehensive garbage recycling improvements. If citizen cannot be encouraged by supporting and offering solutions, laws can always be generated.

Students believed that companies and production are sharing other majority of stakeholders that are holding great effectiveness in interaction order. Students are strongly highlighting that companies and organizations are not just offering products anymore, but it is more like a service that can influence to consumers habits. Like student essay 64 says:

*"At the moment, new innovations have mainly been exploited to the detriment of the intended benefit. Every time a new innovation enters the market, companies promote products as time-changing inventions, causing customers to abandon their old devices, even if they are functional." (E64)*

It was common among the student to discuss how companies often thrive and chase increasing sales. Students think that a direct way to affect to consuming habits is to improve product lifecycles. This means that sustainable methods are assimilated to every step from product manufacturing to the end-use or recycling of the product. How can this affect individual users? Students highlighted that making products more long-lasting and creating opportunities to fix old ones reduces purchasing frequency and in long term it decreases manufacturing pollution, making manufacturing a step greener than before. Students think that following each consumer's carbon footprint is raising as a trend and businesses that assimilate this as a key element in their businesses will gain lot of loyal customers. Another raised question was about how can consumers know which company is honestly sustainable? Concluding from the data, it seems to be all about marketing and consumer participation. Ecological marketing has been trend for decades, as shown in the chapter 2, but more detailed information about origin of the product and company's sustainable action are required to get attention from students. For example:

*“Marketing could require some teaching of customers and the ease of service and the environmental impact of using it would be the core message of marketing.” (E41)*

After companies provide detailed information about their sustainability changes and actions, students said that they are willing to change their behavior step by step, leading to a conclusion of strong effectiveness in the interaction order. Previous research and conclusions from essay data have proved that companies have changed from service providers to teachers of better solutions, and they have a great influence to guide the markets. Companies need consumer feedback constantly, so trends can be followed. Even though, many of the students think that changing habits to be more sustainable is still limited, since the green prices tend to be higher than others. This is seen especially in organic and green food prices, but many students believe that it is going to change. Marketing and responsibility have changed the thinking towards nature and sustainable food solutions are increasing its popularity, as a trend or as part of ideology.

Students overall thought that no matter whose responsibility changes are in the society, in the interaction order individuals/citizens have power in numbers, because of the importance of their consumption habits and this way they can affect larger organizations. If compared to times a few decades ago, modern people have more options to choose whose products they are consuming. Students think that megatrends are challenged to make changes in their production to keep their popularity, because previously they have led people towards their ideology and habits, and they still are, but future customers are challenging this arrangement. Students also believe that companies can make a difference if influencing and green methods are a strong part of deliveries:

*“However, social pressure is pushing companies to invest in this, and it could therefore be thought that it is partly the responsibility of companies to direct consumers' attention to sustainable products, for example through advertising and information.” (E157)*

In conclusion from the data, companies are required to act as consultants of green values and improve their products to more recycling and reuse-based development. Still, students believed that recycling part is still left to people. New applications are changing people's minds and for example, during the energy crisis this year 2022 people have started to notice their daily energy consumption more carefully, leading to thinking of alternative nature-saving solutions. Still, we are living in a consuming-based society, and essays strongly highlight that we should vote with our purchase decisions. Another aspect that has increased people's sustainable actions is the COVID-19 pandemic, which reduced driving, traveling, and consumption, thus leading people to work at home. Students believe that this has a long-term impact on a less consumptive society.

The majority of the students answered every question in their essays, but answers were sometimes shallow. They could pick up major interaction order influencers and the EU targets, but the way they analyzed them was lacking justified reasons. Long-lasting products and public transportation as products seemed the most familiar topic for the students because they are living the times when these areas are changing rapidly, and they are often used in daily actions.

### 4.3 Summarizing the findings

Quantitative analysis was based on the students' 163 student essays in this research. Students were mainly 20-30 years old and currently studying at the University of Oulu, located in northern Finland. Students were given material about the Europeans Green Deal and its targets, and they answered predefined questions, but they also had the freedom to write about their opinions. Collected essays were part of the university course. From these essays, I could get material for data analysis providing understanding and overall opinions about sustainable development. This collected material was used to create a nexus analysis, including discourses in place, historical body, and interaction order of the current case.



From the data I gained from the students' essays, I can make presumptions about northern Finland's students' opinions about the European Green Deal and how sustainability overall is seen, and what factors are affecting current outcomes. We can conclude from the students' opinions that Finland is a developed welfare state where consumption, easiness to move and energy options are felt more important than often necessary felt aspects, like food, nature, and industrial benefits. That is why the top three chosen targets by students were: Long-lasting products, public transportation solutions, and clean energy. This kind of thinking might work regionally, but globally it might not be the best baseline. The majority of the students (68%) see themselves working with the solutions for these top three targets in the future, mainly via technology improvements, but they were not exactly ready to be the ones who create the technological innovation but want to be around it, mainly in management positions. As discussed in previous research, technology has been Finland's strength in the last decades and may be the reason why 74,3 percent of students believe that technology can somehow help to achieve sustainable development goals. A few improvement technologies, envisioned by students, stand out above others that are seen important changes in Finnish society and development: alternative energy solutions, like solar power and wind power; change from gasoline to electric cars and other transportation solutions; artificial intelligence in production and mobile technologies, which can ease everyday tasks and services, thus supporting sustainable habits. Consumption habits are seen to play a major part in the change towards a sustainable society. Almost 56 percent of the students believe in direct effectiveness and 20 percent believe in its effect somehow, leaving only 24 percent on the negative side. So roughly over half of the students believe that investing in new technologies has a significant effect, even though most of the financing is believed to be directed to this sector, leaving consumers' everyday life developing to lesser attention. The majority believes that individuals make a difference, but they do not believe they can do it only by themselves. From the listed influencing stakeholders roughly, 4 percent stated the direct influence possibilities by individual consumers. On the contrary, companies and production were highlighted 43 percent of the students, and public systems and government 41 percent of the essays. EU's influence possibilities were only believed in 12 percent of opinions, even though they are playing major decision-making body in Europe.

Nexus analysis provided a good understanding of students' behavior reasons and changeability. Most popular discourses seemed to be around work and education. The majority of the participating students were from IT-related university programmes, so their daily environment, conversation and information seemed to have direct effect on their opinions about technology development. The ones that mentioned studying other than Information Processing Science, seemed to have opinions modified around their major: economics students thought more about markets' welfare, and industrial students more about development areas of production. The workplace and topics discussed there were mentioned to have value in some student cases. Many knew, from their current or previous jobs, that software businesses have less efficiency to sustainability problems, instead they believe that better communication between product and customers must be released since the changing power is believed to be in higher authorities. Also, the costs of the change seemed to be more known and detailed among the students when they have been in the decision-making processes. Another matter which has created discussion in the essays and previous research were social media because almost everyone uses it and it is commonly used as a communication channel, modifying people's opinions and minds every day. This can be felt as a problematic effect because the correctness of information in social media is hard to guarantee. Geographical locations also seemed to affect the respected values. Students from northern Finland shared similar opinions about public services and energy situations, leading to the conclusion that the same area is holding strong opinions towards these manners. These have not happened in a short time, but people have tended to grow in it. This prompts to question: if people from cities and dispersed settlements are not sharing similar sustainability values, how common, whole Finland covering, sustainability plans can be effective and guarantee the wanted behavioral change?

Not only they have gained a lot of knowledge from modern society, but students also shared a similar current situation. The historical body of the students included a lot of similarities. Almost all of the students were studying information technology or related studies and were interested in the technological aspect of sustainable development. Their pursuit and advocacy have led to proper awareness of technologies around, even though in some cases the understanding was limited. Knowledge of technologies seemed to have an effect on opinions about the direct effect of technology in sustainable change and it was more seen as a tool. They often believed that technology has reached its maximum level and changes have to be made around other things. The greatest differences were seen as respected values about changes in public services: northern Finnish students were more concerned about the availability of services and needs, or restrictions, about public transportation and moving around at all. From the essays, it seemed obvious that students were worried more about changes in their area, and life, and considered certain targets unnecessary, without seeing the big picture. Otherwise trust in society was high and belief in its importance in change was valued. They also have adopted green habits by using secondhand stores and repairing their electronics.

Interaction order resulted in five different major actors: EU, Public System, Companies, Production, and Individuals. Among the students, the EU was given a low valuation as a change maker, giving a public system (society) great power to affect individuals' behavior. Students believe that Finnish people are used to following regulations and changing the public services will thrive individuals towards the needed sustainable change in time. Society can support the green change plans by providing enough resources. Also, they should provide proper educational opportunities for people to educate themselves and respond to future job needs and requirements. Society is believed to have a less direct effect on consumer and purchasing matters. These actions are highlighted in the data, as being in the companies' responsibilities because their provided information and sustainable business development are believed to have great effect when it comes to purchase decisions. Students believe that in Finland, products and public services are the most important development areas, which are out of individuals' hands. Businesses are not only understood as products anymore, but they are also trusted as information providers who can affect purchase decisions immediately. In the end, the most believed change maker, consumer behavior, have gained a situation and base to make the actual change for sustainable efficiency. As a controversial aspect, the importance of consumer behavior is the most highlighted in the essays, but the responsibility to provide this is in the companies and society. Students are aware of new technologies but often think that they have limited themselves, leading to organized change by society laws and organizations' regulations.

Students commonly believe that the industrial transition is happening slowly, and it requires the support of greater actors like the government and the EU. Also, they thought that it is important to understand different geographical locations. Energy is believed to be more expensive in the areas where it is required the most, like in northern regions. Building new houses and repairing old ones are understood as expensive solutions. New regulations can be challenging to answer in certain areas, where alternative energy and method solutions are not possible. As summarizing the energy situation and thoughts, replacing energy solution is believed to be found in the next few years. Solar and wind energy have raised their popularity around the world and innovation for energy preservation are believed to be innovated. New buildings are built by using artificial intelligence and monitored by different kinds of sensors and meters, together with data collection.

Based on the analysis, many factors related to discourses in place, historical body, and interaction order affect how students see sustainable technology development (see table 9.). These results can help one to understand students view about sustainable development, and what factors are present and influencing to students' everyday decisions and opinions about sustainable and green future.

**Table 9.** Factors linked with Discourses in Place, Historical Body & Interaction Order.

<b>Nexus Analysis Findings</b>		
<b>Discourses in Place</b>	<b>Historical Body</b>	<b>Interaction Order</b>
<p><b>Education</b>            Chatting in university and with co-students (ICT students look for technological solutions, economics student focusing on economics and different engineering students to steps of manufacturing).            IT and engineering related studies (different angles of discussing the interests).            Teaching topics in different faculties (what are discussed in courses).</p>	<p><b>Nationality &amp; Place of Living</b>            Accustomed to Finnish rules in the society.            Finnish culture in everyday living.            Living in cities (transportation, habits, and values).            Living in rural areas (transportation and values).            Freedom of speech and decisions as basic western rights.            Living on your own.</p>	<p><b>EU</b>            Support collaboration with European countries and companies.            Support financially and operationally the member countries.            Provide similar standards &amp; policies.            Diversify education possibilities to meet current market requirements.            Competition control between member countries by using product requirements.</p>
<p><b>Work</b>            Discussions at workplace: recycling, green habits, and own actions.            Discussions about support from government for sustainable changes.            Managerial positions: rules and ways to effect with careful planning.            Decision making at work – how to make work ethics and environment cleaner.</p>	<p><b>Education</b>            Students at University of Oulu.            Field of study: IT or engineering related.            Daily educational activities: group works and assignments.            People around you at university.            Technology oriented mindset (interest towards ICT and purchasing choices within personal electronics).</p>	<p><b>Society</b>            Regulations (laws, rules) to support cities and companies.            Financing and supporting companies green change and development.            Education (work training and future job education) possibilities for needed change.            Improved public services (transportation, healthcare) for individuals</p>
<p><b>Media</b>            Discussions about innovations and technology development.            Increased green product marketing and information among daily discussions and news.            Capitalist consuming marketing modifies the consumption decisions and opinions.</p>	<p><b>Work experience</b>            Recycling and waste management at work have modified the way of thinking and actions.            Management position: understanding costs and challenges in sustainable choices.</p>	<p><b>Companies &amp; Marketing.</b>            Marketing as a teacher for consumers (product transparency and educating benefits of sustainability).            Pricing supporting the green change. (Availability and affordability)            Customer participation for development – what is needed and required depends on the area.</p>
<p><b>Technology</b>            Common critique towards downsides of sustainable development (fast development, battery industry).            Believe in technology-based change which decreases the consumption.            Believe to new laws and regulations to support the change.</p>	<p><b>Public Services</b>            Accustomed to welfare society and services (easiness and public support) have modified the understanding and opinions about sustainable world and necessary changes.</p>	<p><b>Production</b>            Product recycling as key factor in sustainable planning.            Product reuses have to be possible for the end users.            Usage of the best and greenest. energy solutions (options vary depending on area).            Product alternatives for consumers (price, values, and quality).</p>
<p><b>Culture</b>            Approving and conforming local and European values and habits.            Discussion about local trends and laws in countries, markets, cities, and regions.</p>	<p><b>Age</b>            Similar age: between 20-30            Bachelor level studies in the university (recently started university).</p>	<p><b>Individuals</b>            Individual consumers habits considered the most meaningful in the change.            Workplace rules: regulate or order sustainable work ethics.            A wareness education as a part of work training.</p>

## 5 Discussion

In this thesis, I answer to following research questions 1) *what the student's thoughts and opinions about sustainable development are*, and 2) *how we can use the understanding of elements behind students thinking to change human behavior in sustainable technology development?* I first collected and read through all the students' essays and made notes in an Excel table about each essay. This table included sections and answers for ten different questions, giving me data for quantitative analysis, and later deeper understanding with nexus analysis. I used these two analysis methods in my thesis. I chose these methods because they gave me an overall understanding of the students' perspectives and opinions when it came to sustainable development and the European Green Deal targets. The analysis was divided into two different parts because I believed that understanding the topic deeply required both together. Some of the questions were simple yes or no questions, in others the students had to pick targets. The rest was mentioned topics listed under specific categories, that were later used as perceptions for nexus analysis. One of the main questions and goals in this thesis was to understand Finnish students and the culture of sustainability and find out what kind of values are strongly respected and what areas in markets and society are seen as important. Students had good chance to tell their opinions in the essays, and also develop their visions about future development. This gave a good understanding of base knowledge about what they know and value from the current development situation. Some surveys are made on a similar topic in Europe, but a deeper understanding of Finnish students, the future developers, are lacking in some points, so nexus analysis is needed for future development.

### 5.1 Students thoughts and opinions about sustainable development

According to students, it seems that sustainability and green thinking have raised their popularity among individual consumers. In Western societies, consumption has been exploding in the last decades, since purchasing and services have increased enormously with mobile phone applications and digitalization among organizations (Hart & Milstein, 1999). As discussed by Hart & Milstein (1999), consumer economics, a high wealth per capital level and a high consumption level present in Western societies can be seen to strongly affect student essays. From the essays, we can tell that Finnish students are aware of different product developments and organizational methods via social media and news. When it comes to research question one, students are strongly thinking that companies and governments are to make huge changes if they want to achieve the EU's Green Deal targets, but they cannot do that only with regulation. Data from the essays also shows that students believe that consumer behavior has to change towards green thinking and that change can be made if mega trends and influencers support this change by changing their own actions and product planning. Reflecting on question one, this can be considered a challenge to an organization because cultures, values, and habits vary a lot between different countries and even between geographical locations. This challenges companies to have enough knowledge to recognize the market area and values prevailing there currently. Students think that different market areas have different purchase powers, and their local production can be contaminated, or even dependent on great factors. If we compare the gathered results with the Maciejewski & Lesznik (2022) research and what Finnish students wrote in their essays, we can tell what is emphasized in the different areas. SDGs targets can be understood differently. Polish citizens see sustainable development around clean water, food, and human values such as equality (Maciejewski & Lesznik, 2022). The same ideas were seen in a survey made in the UK (Archer et al., 2022). Long-lasting products and electronics solutions were only seen 12th most important (from 21) when in the Finnish students' essays, these were by far number one. Changes in transportation habits and their development were also in a low position (16/21). Students also state that this is also a cultural and societal thing, since metros, local trains, and other transportation methods are commonly used in other countries and bigger cities. According to the gathered data for the study, another difference was about renewable energy solutions, when British people in the

research (Archer et al., 2022) saw energy solutions as only the 17th important change or development target, when Finnish students saw it as number three.

Reflecting on research question one, from the results of the essays, I can conclude that students see the most changes in the future around product development, public services, and clean energy solutions, which shows the difference between these countries. A common thought in the student essays was that Finland represents a consumer economy, high level innovations were seen as problematic. Food and environmental issues were at the bottom of the valued Green Deal targets and only a few wanted to make solutions for these problems. The reasons for the opinions on these topics seemed not to be income, since as we saw from the research made in Poland by Maciejewski & Lesznik (2022), Poland has lower salaries than Finland, but a majority of the student were not working full-time at the time, so personal income might not be the explanation. Also, in the UK average salaries are relatively high (Eurostat, 2022). These facts indicate that Finnish students and citizens have adjusted to live in a supportive environment, since education is free, and the government supports that journey thus living expenses are paid when you do not have a job. Students identified Finland as a capitalist society and constant purchasing is seen as a problem, but surprisingly fault for this is not seen in individual consumers, but mostly around product developers and society. In the research made in the UK (Archer et al., 2022) primary reason for not adopting more sustainability is related to costs, which can mainly be influenced by providers, and companies. Responsibility is given to higher decision-makers and that way product and public service users can make a difference.

From the essays collected for the analysis, we can conclude that Finnish student awareness about sustainability and its technology development seemed to be at a high level, justifying the conclusion for question one, and the dataset indicated that the students drew on public discourse on the topic. Some students mentioned that social media and many platforms for information have influenced their way of thinking. If we compare to the research made in the UK (Archer et al., 2022), almost half of the British participants mentioned not having enough relevant information about the effectiveness of change or the global situation overall. Based on collected student essays, situation in the UK is different than in Finland. One problem noted in the essays was that many mega brands are using constant green marketing to increase sales, but little by little they are forced to change their delivery to become more informative because customers are thinking more greenly. As mentioned earlier in the background section, for decades businesses have used green marketing as a strategy, sometimes without greater green changes (Peattie, 1995). Students stated that businesses and brands can no longer just use it as marketing value, but there has to be something behind it. For example, many producers are uplifting their environmental responsibility by changing everything to work with electricity, but as we saw, many of the students were aware of the faults of the battery industry, which was one of the most mentioned negative issues in the answers.

The students mentioned the EU is a strong actor with regulations when we want to change methods and behavior to become more sustainable. Students in their essays believe that if the EU gives some rules and regulations, Finnish companies and society will follow, but how rapid the change is, only time will tell. Many students believe that the EU cannot make detailed instructions, but can support companies financially, this way allowing them to plan their companies' internal changes. Almost 70% of essay writers believed that real power is in governmental decision-making. Even though, citizens have their own opinions and mind, following rules was stated as easier in the essays, and that will reflect on individuals' actions in time. Students believe that society might not have enough power to make regulations for factories or product development, so international standardization is believed to be a key element for this change. As an ideology it sounds great, but based on the previously made research, the technology field is rapidly changing, so other companies' methods might not work in another company, but change is possible in the long term (Tukker & Tischner, 2017). Data from the essays told us that companies influence forcing consumers to certain changes in their life via services and products. As we learned from previous research (Hart & Milstein, 1999), capitalist societies, which aim to gain money and capital where people purchase products to satisfy themselves, can be

changed together with developing digitalization. This is strongly affecting each opinion, giving insights to research question one. Green pricing was believed to be more expensive, but many of the students were willing to pay more for environmental products, but not necessarily for service, which can be a challenge to companies to provide required and wanted information. As mentioned in research made by Segev et al. (2016), some people are ready to pay extra or make more effort if they surely know that the company is aiming for climate change support or sustainable development. As an example, from the essays, public transportation might be difficult for someone because of their location, as using it might require more effort. Only promoting the digital product as sustainable is not enough based on the UK research (Archer et al., 2022). Students stated in the essays that change needs to be addressed to certain wanted areas because environmental responsibility might sound huge and unreachable by individual users. They also believe that digital product providers need to be also sensitive about their information by providing natural and realistic information about their company's sustainability goals and situation. Too forced change was not seen that welcomed among the students. Students discussed challenges of change buying habits because if we compare physical products and when you get the same solution with the same effort, maybe a little bit cheaper. As Belz's (2001) study proved, people are gaining more knowledge about production methods and green elements, so the price is not always the issue.

Students strongly highlighted that geographical location affects consumer behavior strongly because values and services can differ. Many students stated that they have got used to public transportation abroad and in southern Finland, but in Oulu they would rather drive their car, using the busses only when necessary. Some students were from the countryside, and they are used to living without everyday services. Even though Finland is believed to be a modern and Western society as overall among the students, differences with services are seen between cities. Hart & Milstein (1999) radically divided the world into three different societies, but values can vary inside the society too. The main differences notified by the students were between Finland and other example countries that Finland has good healthcare and governmental support system, allowing everyone to study, buy and use every service, usually for free. This leads to the conclusion that green choices, when it is about using public green services is individuals' decision. Also, students states that Finnish people were seen to be enabled to gain more information from the internet and news, and the majority of the students acknowledged themselves about occurrences abroad.

Freedom of speech and actions are actively mentioned in students' essays, and that is also seen as challenge for regulations to make changes. The essays indicated that new laws can always be made, but it is not considered the most efficient method. Sense of freedom is strong in Finnish identity and history, which is affecting opinions and purchases. Also, background (jobs, education) is affecting students' points of view. Students' who were studying economics, tend to think more economically about sustainable change and businesses own targets were more central in the essays. In these essays, environmental issues were seen important, but not seen as key issues. Majority of students were studying IT related studies and they saw software and information systems development as green as it gets. They mostly see how people can be influenced with created products. Students who had experience from management positions saw the problems with costs, and knew the difficulties of change, leading to statements that green change will come, but slowly. Becker et al. (2015) divided consumer purchasing reasons into three aspects. They have concluded that maintaining the trust of customers and same time leading to green change, social-centric and eco-centric development must go hand in hand. Students thought that this might require more close research and development together with company and customers.

As I have learned from essay data and previous research, the one important aspect for developers and companies is to recognize cultural and societal factors. These have a great effect on opinions and conclusions for research question one. Like discussed in previous research, globally we have areas where technology and service levels might vary significantly (Hart & Milstein, 1999). When it comes to increasing sustainability awareness, the same problems do not touch all people even in the same

country. I have previously discussed how, even in Finland, people are living in less populated areas, outside of concentrated services. Their daily consumption, transportation, and energy values vary significantly from the ones who live in the cities. That is why marketing, product design, and technology innovations have to be designed to serve these consumers' needs and values. Otherwise, I have concluded that investing in green changes might not give wanted results, leaving gaps or even turn out giving negative effect, after changes and pricing. In the modern market, previous research (Geysler, 2023) has proved that change makers have opportunities to reach these people quickly, for example by using social media and other mobile based channels. Diversity is the key when you want to reach and touch people around the globe. That is how you might gain more active customers and persuasive design might have bigger effects on the outcome.

From the data gathered I can conclude that sustainable development will require major changes in manufacturing, companies, and consumer habits. When it comes to talking about corporate structure changes, students will be soon a part of the organizations, and their thoughts should not be underestimated. To answering to first research question, this kind of research is giving great opportunities for local companies and actors to have better understanding, thus giving a higher success rate in the areas they want to influence. This also includes businesses that want to improve their sales, but also support their green change development for the future. Focusing on a specific group of people, who shares similar educational situation is a great opportunity for companies and society to make a change and find the solution, that will affect these people and future technology developer of this country.

## 5.2 Change in digital technology and design

To answer the second research question, we must also consider the company's side in sustainable technology development. Students strongly states that development and innovation toward a sustainable world have begun, and changes can be seen in different organization strategies and methods. Also, previous research (Kleanthous & Peck, 2006) proved that businesses are optimizing their green strategies, even though changes can be small. This has been noticed by students too. The government and EU are doing their best to support his change, but students think that it will not happen without challenges. Students emphasized that consumers might start thinking of the environment if the information is shared and understood, and society, and businesses need to understand the specific needs and values in different areas, answering the research question two. Many students also came up with a question, how to increase the willingness to decrease private driving or convince people to pay more for green products, if a non-sustainable product is cheaper or even better? Based on the essays, some people are ready to pay more, if the product has green deeds behind the price. Students thought that persuasive and participative design in sites and applications was seen as important in some cases to change behavior towards this ideology. Like (Geysler, 2023). stated, this can be seen in focused marketing and in social media, where companies and influencers are changing individuals and habits by relying on the power of the community.

On the negative side, data gained from the essays proved that forced regulations and laws might just turn into negative impact when consumers have the right to make their own decisions, once again an important aspect of development. Conflict of interest between costs and ecological actions have to be resolved by changing the ideology deeply among consumers, otherwise, the same question arises at every point in everyday life. Student highlighted that challenges in Finland include geographical locations and public services with it. Students strongly stated that it is hard to think of the development of public transportation for example, when it does not belong to their normal day outside of bigger cities. As mentioned in previous research by Ahern et al. (2013), technology has a strong influence on consumers, so it is important to recognize meaningful products and strategies for how information and technology can persuade the user towards better solutions. As the background research concludes, research communities have focused mainly on society-level concerns, leading to situations where

these theoretically proven methods are sometimes carried out incorrectly, leaving consumers values unnoticed. As a downside, students in this research believed that in some cases, rapid technology development is considered to bring risks to end users, because of security risks and hackers are using more advanced methods to gain information. That is why students proposed that companies should then remember proper planning and launching of the product.

Students in this study believed that there are also good opportunities for businesses and consumers. Through standardization and regulations product life cycle will be improved at every step of development, allowing the product knowledge to spread around the globe. This is stated by the students to be one of the key elements to make sure that technological development is happening around the globe. The change can be seen, when service providers change focus from techno-centric concerns to socio-centric concerns, through education and value understanding. As concluded in the background section by Becker et al. (2015), technology designers need to recognize that lifestyle behavior change is a long-term endeavor that pervades everyday life, including the social world. If done poorly, students thought that the technology is likely to be abandoned; therefore, a principled approach to its design is needed. These kinds of qualities are important and concluded as a part of the answer to research question two. In some cases, the students emphasized that individuals would get more knowledge about products thus receiving important information, when companies are moving from providers to teachers, as ideology. Students commonly agreed and stated that new green energy solutions are constantly developed, and remote locations might benefit from these innovations, and it will offer more efficient and maybe cheaper energy solutions. This decreases dependence on other countries, providing a more stable system.

One of the key elements and conclusions for research question two is that many students thought that businesses' key target is to wake emotions and thinking among the consumers if they want to stand out in competitive markets. Like discussed in the chapter 2, persuasive technology and participative design are gaining more popularity as design method. Many students think that it is the organizations' responsibility to make the change, so that consumers can follow it, in which gamification and persuasive technology can offer a solution. As Oinas-Kukkonen & Harjumaa (2009) predicted, marketing will continue to attract persuasive technology researchers and developers in the future, creating whole new methods to affect consumer habits, even to help achieve a better, sustainable world. Students in this study believed that this all is happening because of the growth of e-commerce, mobile applications, and versatile software development, when technology is understood to be already in high level. In societies with freedom of opinions, this is nothing but an easy task. As we concluded from background theory, organizations should take advantage of raising trends and trying to prove in their service their sustainability targets, not only in commercials. Students have noticed that many electronic product providers have started informing electricity consumption with details, giving users perspective, but also forcing other ones too to publish the numbers, also putting pressure on high consumptive product providers, making this kind of elements important in product design, and reflected to question two. It is also strongly highlighted by the students that being transparent with production methods and how the company is concretely making green changes is seen as important. This can lead companies' strategy from human-centered design to nature-centered design, and still provide the same service for its users. Students think that every product should include product information and origin, together with the carbon footprint caused. As many companies have done, students support the idea that product prices might include extra in its pricing, if the extra money is guaranteed to use for sustainable development or environmental use. This kind of thinking was analyzed by Segev (2016) and named green pricing. Together with the right targeted commerce, students believed customer behavior to change. Another important aspect mentioned by the students were that products and business methods should be comparable, so customers can choose the service which is most fitting to individuals' ideology.

Students emphasized that almost all companies have been affected by digitalization and their products or support can be found online or as mobile phone applications. To reach customers in modern



markets companies have to remember this, but also answer question two from a design perspective. Previous research (Goodbarber, 2021) has noticed that the latest one is pushing its way to become the most important tool for individuals to perform everyday life actions. Students are mostly considering the use of green products and the use of public services, something that requires encouragement. Giving relevant sustainability information and providing examples of change can affect users'/consumers' opinions directly when using the product. In the essays, some students have noticed that sustainable change does not always need to be felt negatively, but giving a feeling or an experience to users that they are giving something back to earth, might motivate users to improve their sustainability actions in everyday life, also as a part of an answer to research question two.

Previous research has noticed that gamification has increased as a trend via mobile phone applications. Buznea (2021) has proved that during the last years, many companies have improved and familiarized gamified schemes to increase customer or employee engagement with great success. Consumers are spending an increasing amount of time with their phones and students are aware of that. Many students believe that making application services (public services) more rewarding and game-like will increase usage. This kind of game particularly conveys persuasion goals to promote environmental issues, promoting more sustainable habits. Good examples of this were a student's idea of a common transportation system application that covers all cities and means of transport. Students envisioned a solution where paying the same price every time can be consuming, but if you get rewarded for it, your beliefs might change. Some students suggested that few trips with busses should give you a certain time of travel by electric scooter, as a reward. You will get the feeling that you are helping the earth thus supporting sustainable development, but also gaining something for "free". Mobile phones and their applications are available and used actively during the day, so green solutions can be good to develop for that platform, either as a new application or re-designing old ones (Buznea, 2021). This kind of interaction design strategy is believed by the students to participate more users to improve the sustainable future, even with small steps. So as conclusion, green production and participation should become a strategy of the organization since it has proven to be a trend in the modern market.

If I think about the conducted research and its results, consumers can influence and make changes in markets, but the initial action has to start from the organization. When I first started to analyze the essays, I had some presumptions about the knowledge level of Finnish students about sustainability, since Finland has always been a nature close, and clean country, but consumer economic values were strong in students' discussions. It was surprising how strongly the responsibility is given to higher decision-makers, but still, individual actions are seen as necessary. Previous research proves that different consumption market exists (Hart & Milstein, 1999), and from the student essays we can conclude that Finland is categorized as a highly consumptive society where basic elements of nature are seen as even self-evident. That is why the top three of the EU's Green Deal were clear: long-lasting products, public transportation, and pure energy, leaving nature close and bigger industries, like constructions, factories, and pure nature to little notice. They were mentioned after all in many essays, but deeper understanding and analysis were mostly lacking. Long-lasting products were a top target because people do not want to spend that much money on products, but also, they know how low-quality the product can sometimes be. Public transportation was the second pick because a majority of essay writers were from the northern part of Finland, where they have become used to driving their cars. Clean energy is seen as important by the students because it has been so much in the news lately and Finland is among the top countries in the world with sustainable energy solutions, but also wood is so commonly used that higher electricity prices were noticed when the energy crisis occurred.

I strongly believe, like students in their essays, that businesses can make a change. It starts by changing their internal actions, but their services have to be changed to more encouraging towards sustainable thinking. "Normal markets" are competing with prices and quality, but the increasing green thinking trend is taking a cut from the markets (Kleanthous & Peck, 2006). This cut has to be

notified, but also tailored information sharing contents and solution has to be made. As I saw in previously made research, markets tend to have different natures and unfortunately, the biggest ones are in the countries where society might not force the industries enough to make a difference and enormous consumer quantity is allowing selling anything when customers do not have knowledge or possibilities to get the background information. Occasionally it is not even seen as necessary among the students, pointing once again to the responsibility towards industries.

Another novelty in the essays was the forcing of the green intention of companies. Previous research has provided information that too much plying might decrease the credibility of the companies and make consumers feel that their actions might not be required. As Belz (2001) presented, not everyone has money to buy and support sustainable proven products, and this leads one to wonder, can I even make a change? Also, green commercial leading might be felt as greenwashing, because some companies are highlighting their green intentions, even though they have not made any changes in their product life cycle. This is seen in the research made in the UK (Archer et al., 2022), when almost half of the participants in the UK discussed that they have not made any sustainable changes in their lives because lack of information from product providers. Sustainable change should be informed correctly, and product background should be transparent. In the EU, where the same market area is following certain regulations, cultures also differ a lot, which challenges organizations to find solutions and knowledge about which values are strong and which are not, not forgetting the worldwide resolutions. This was also stated by the students and that is why I can conclude it is directly affecting to sustainability marketing and its goals in the companies.

Students' backgrounds, especially discourses, were not mentioned that much in the students' essays. Students barely talked about their families, friends, and their close inner circle, which have a great influence on their thoughts and beliefs. Recycling seemed to be important to most of the students and some of them even mentioned doing it actively. Reasons behind students' actions and understanding sustainability were not often mentioned, leaving questions about where these actions and opinions are originally coming from.

One main challenge of students' essays was the nature of the original task. Even though students had the freedom to speak and analyze whatever they wanted, the essay was a mandatory part of the course assignments. The reasons for chosen topics (EU's green targets) can be influenced by the easiness to write about the topic, which might affect the outcomes. The dataset included a large number of essays, namely 163 essays, so the effect of these deflections could be minimized. These answers could be used for the quantitative data analysis part, leaving only interpretations or the nexus analysis part. The third problem that occurred was related to students' backgrounds. They did not talk about their background and relationships in the course assignment. This highly affected to results for the nexus analysis discourses in the places section.

Information and outcomes of this thesis can be used for companies and organizations that want to be aware of consumers' minds about sustainability and what kind of history and effects there are behind the actions and decisions. Advertising green values is not enough without the ways and methods to get inside the consumer's head. Material is not only suitable for an organization that aims for profits but also for society and its actors inside Finland's borders who are willing to chase the European Green Deal targets. These non-profit organizations can make changes in everyday services and take steps toward more user-friendly solutions and try to find solutions for background actors on how students might take the next steps toward greener lifestyles. For future research I would recommend making country-focused research about which sustainability values are seen as important and which targets (EU for example) are seen as important to change in specific areas. That helps organizations to plan changes through behavior when they have an understanding of what consumers' ready focus and change are because if the green change is affecting something that is not considered important, the readiness to change is low. Another aspect that should be examined is the knowledge level of sustainable development and green product that are currently in the markets or under development.

The students' essays provided good base for understanding current knowledge of sustainability as a concept. Product information should not only tell the pollution levels of its production, but companies should start proper teaching about the benefits and disadvantages of decisions. This style has been in the market for a while, but because of greenwashing, transparency of the companies is emphasized.

### 5.3 Outcomes and implications

Human, especially consumers, behavior is not always easy to understand, but is significant factor in a sustainable change. This was seen in the difference in values and necessary changes from the UK and Polish research, where, even inside the Europe, sustainability is seen differently. That is why these values need to be notified and respected if higher actors want to improve the sustainability changes in individual level. From this thesis, I have listed most relevant matter than are present and what should be remembered during behavior change operations:

1. Different locations have different consuming habits (cities vs. rural areas).
2. The importance of sustainability values varies between areas (welfare vs. developing countries).
3. Public services are used differently in dispersed areas (decisions can have negative effects).
4. People's level of awareness about sustainability and its technologies varies (do not make assumptions of interests).
5. Improve the reliability of your product's information (overflowing amount of information available in the markets).
6. Society should share resources for the companies to change (easiness to change and pricing).
7. Businesses should use modern techniques to improve awareness of sustainability innovations (social media, influencers) and provide accurate information.
8. Work and education background will affect interest towards changes (versatile approaches and change strategies).

Previously mentioned information is respected, and necessary information collected and learned, can these higher actor, mentioned earlier as major elements of interaction order, start planning and diversify their products. It is not always required to create something new, but like research participants often mentioned, current technology products are already in a high level in Finland, these products just need more transparency, informative and educational intentions, and persuasive strategies, because product itself is not a solution for sustainability, it begins within the users. In the product development, organizations should follow the listed factors to guarantee the success in the change towards sustainable production and future:

1. Make plans together with a consumer (values between areas vary significantly).
2. Design your product for a particular area (notice culture, interests, and habits).
3. Make sustainability the key element throughout the product-cycle.
4. Sustainable change should improve the easiness to use current products.
5. Make your physical products recyclable and components replaceable.
6. Pricing should be lower or limited (availability for everyone in different market areas)
7. Be transparent with the origin and production of the product (a lot of available information).
8. Provide invigorating info about sustainability's decisions and effectiveness (why change).
9. Favor and support co-ownerships (current trends and availability for everyone).
10. Technology is not always a solution in itself (persuade and teach the consumer).

## 6 Conclusion

The objectives of this thesis were to find out the reason behind the individual behavior towards sustainability decisions and thinking, but also, what methods designers and companies should use to guarantee the behavior change within the customers. Two research questions were composed: 1) *what are the student's thoughts and opinions about sustainable development?* And 2) *how can we use the understanding of elements behind students thinking to change human behavior in sustainable technology development?* Students' essay material was used as a key topic for understanding Finnish students' way of thinking about the European Green Deal and sustainable technology understanding overall.

It seems that students had good awareness levels about current technologies, energy solutions, and especially product knowledge when it came to sustainable and energy-saving product development. Recycling, fixing, and supporting green products were somehow endorsed by everyone. Original university course assignment material increased the knowledge of participating students and many of them were ready to make changes. Many of the students mentioned having some green habits in their daily life and they knew what changes they should make, but many saw a barrier with pricing, availability, or quality. They believe that individuals can make a huge difference overall, but strongly pointed responsibility to organizations to provide an easy and effortless environment, likewise services, for this change. Most of them believe that the EUs' Green Targets can be achieved, but roughly over half believe the technological development has a direct effect on that change alone. That is why I can conclude that changing consumer behavior together with changing sustainable production, values, and daily habits might have great improvements for the globe.

Students were aware of technology development and its innovations. One reason for that was that the majority of the students were studying technology-related studies. Their surroundings in school and daily activities are providing ongoing information about technology, so it have created strong opinions about the current situation and the effectiveness of sustainable change. On the other hand, many students mentioned adapted to recycling habits by using secondhand stores, fixing their electronics, and recycling their trash even more carefully. They believe that their actions can have an effect, but electronic-oriented people tend to blame mega brands and businesses for creating their consumption habits the way it is. Once again, no proper introduction to background could be seen, but their current student surrounding and situation was similar, likewise, the majority were born in northern Finland, so they share similar social and service background.

Companies' marketing, sustainable changes, and information-providing decision are playing a major part in the future green change. Marketing channels have changed radically from traditional ones to social media-based marketing and influencers are affecting it strongly. EU was not seen as a strong game changer than society, but society cannot make a great difference without collaboration with companies and given regulations. When compared to other countries, a welfare society is important and noticeable figure in consumers' minds. When many things are working and are well-organized, you often forgot situations in different areas. It seemed that there are great differences between areas in Finland, where people have different customs for public service usage and consumption. Students had a big belief that technology will change for the better and be more affordable because the media is constantly providing news and information about innovation and changes, which has also led to believes that technology is already at the required level, and it can by itself save the planet. This might be a negative effect on individuals' belief to make changes by their own decision, leaving habit-changing persuading for service providers and companies.

This thesis began with a literature review by introducing sustainability as a topic around the world and how it is seen in product design and organizations. The first part of this background and theory part was about a sustainable world and organization leading to introducing of persuasive technology

and changing consumer habits. The last part took a peek at a sustainable interaction design in practice and what elements should digital product developers notify and remember during the intentional sustainable change through the product. In the methods and material chapter, the background of the students was introduced, and details of students' assignments were detailedly explained, since it formed one of the fulcrums of this thesis. Data were collected as a part of the course at the University of Oulu and the majority of the students were Information Processing Science students. After this, the challenges and opportunities of the material were analyzed, and also, the nexus analysis method was more deeply introduced as to how it will be used in the thesis. Students' essays were analyzed using two different methods: quantitative analysis and nexus analysis. The first part of the Analysis and Results contained a data-collection about students' sustainable thinking and opinions about EU's targets and also listed themes and topics that were raised in the essays. This led to deeper analysis via Nexus analysis which was divided into three different sections: discourses in place, historical body, and interaction order. These results were summarized at the end of this chapter.

While researching the topic, I faced some limitations that affected the literature review and development of an overall understanding. Analyzing sustainability understanding and consumer behavior is a relatively new topic since the EU Green Deal goals have spread to society's action just recently in the last few years. Also, this kind of research about university students' points of view has not been made before in Finland. I had to research different regions and market areas to have a base for sustainability understanding and how the changes in every-day-life are assimilated and what kind of thoughts it raises. Another thing was that consumers are affected by so many actors nowadays that understanding the real reason behind the change required a lot of statistical background checks for the literature review. Society structures and human behavior with products and services have changed radically in the last decade, sometimes leaving gaps for certain research, and understanding. When it comes to students' essays, there were a lot of similarities and repetitive issues. The majority of the students mentioned that they have started to focus on recycling and more sustainable and green action once they moved to live by themselves and when they grew up. Taking responsibility from own actions tends to lead to a situation where alternatives are often considered. Many students shared the similar studying and living situation when few of the EU's targets raised over others, mainly because of everyday experiences from their own lives.

In this thesis, I made a deeper analysis and understanding of Finnish students' opinions about a sustainable world, and it should be developed. As a conclusion, in this kind of society, companies and organizations are playing a huge part in a change towards a more sustainable and greener world. This gave a good understanding of consumer behavior and thoughts. For future research, companies and organizations can make more research about consumers' thoughts and get familiar with sustainable values that are considered important. We can see from previously made research that values differ a little bit depending on the area and without thorough market research, attempts to change the behavior can be difficult. Reasons for behavior cannot always be seen from quantitative analysis and data because reasons are deeper than that.

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# Appendixes

## Appendix 1. What problems / challenges will be seen in the future?

Transportation	Products and Manufacturing	Nature
<ul style="list-style-type: none"> <li>- <b>Unwillingness to use public transportation 5</b></li> <li>- Car is necessary 1</li> <li>- Easy to use own car 4</li> <li>- Expensive electric cars 4</li> <li>- Logistical disturbances 1</li> <li>- <b>Accidents of a new innovations 5</b></li> <li>- Difficulties of car producers 1</li> </ul>	<ul style="list-style-type: none"> <li>- Unwillingness to produce too long-lasting products 4</li> <li>- Deterioration of quality assurance 4</li> <li>- <b>Battery production harms the environment 17</b></li> <li>- Recycling not profitable 4</li> <li>- Transfer of manufacturing abroad 3</li> <li>- Increased imports 1</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Mega polluters 4</b></li> <li>- Agricultural pollution 1</li> <li>- Animal and fish habitats 3</li> <li>- Nuclear waste problems 1</li> <li>- Weather differences 1</li> <li>- Insufficiency of natural resources 2</li> <li>- Desertification 2</li> </ul>
The EU and other countries	Individuals	Energy
<ul style="list-style-type: none"> <li>- Excessive enforcement of EU laws 2</li> <li>- Goals have no monetary value → unwillingness to change 2</li> <li>- Who monitors compliance? 4</li> <li>- Lobbying 2</li> <li>- Exploitation of new loopholes 1</li> <li>- No possibility of organizing or financing 4</li> <li>- <b>Industrial transition 5</b></li> </ul>	<ul style="list-style-type: none"> <li>- <b>Spending habits 90</b></li> <li>- Unwillingness or inability to behave ecologically 4</li> <li>- Dietary habits 1</li> <li>- <b>The green choice is expensive 7</b></li> <li>- <b>Growing income inequality 7</b></li> <li>- Product awareness 1</li> <li>- People's technology awareness 4</li> <li>- Addiction 2</li> </ul>	<ul style="list-style-type: none"> <li>- Continued preference for non-renewable energy 3</li> <li>- Solar energy poor in areas where it does not shine 2</li> <li>- Dependence on Russian natural gas 1</li> <li>- Clean energy develops slowly 4</li> <li>- Growing energy demand 2</li> <li>- <b>New energies expensive 7</b></li> <li>- Wind power weak 1</li> <li>- Geographical location 4</li> <li>- <b>Weak energy 6</b></li> </ul>
Education and Employment	Business	Public / Cities
<ul style="list-style-type: none"> <li>- <b>Disappearance of works 19</b></li> <li>- Company bankruptcies 5</li> <li>- Overtraining 1</li> <li>- Diversity of education in the world 1</li> <li>- Education stronger than the labor market in the EU 1</li> <li>- Highly educated vs. Low-skilled 1</li> <li>- How to guide people 3</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Conflicts of interest between money and ecology 10</b></li> <li>- <b>Decrease in sales 11</b></li> <li>- Markets that encourage consumption 1</li> <li>- <b>Choice of green expensive 11</b></li> <li>- Recycling software/products lazy 4</li> <li>- Price tag of investments 4</li> <li>- Image maintenance 4</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Geographical locations 18</b></li> <li>- <b>Sparsely populated areas 10</b></li> <li>- Reduction in equality 4</li> <li>- Urban infrastructures at different levels 5</li> <li>- Inability to develop public transport 3</li> <li>- Expensive to create new jobs 1</li> <li>- <b>Urbanization 8</b></li> </ul>
Construction	Food	Technology
<ul style="list-style-type: none"> <li>- Apartments waste a lot of energy 2</li> <li>- Changing/Different Weather Conditions 6</li> <li>- <b>New construction and repair expensive 8</b></li> </ul>	<ul style="list-style-type: none"> <li>- Unhealthy food more attractive 2</li> <li>- Unhealthiness of laboratory food 1</li> <li>- Healthy Food Marketing 2</li> <li>- <b>Healthy food expensive 7</b></li> <li>- Inequality among farmers 1</li> </ul>	<ul style="list-style-type: none"> <li>- Risks brought by artificial intelligence 5</li> <li>- Technology is not ready to replace everything 4</li> <li>- <b>Rapid technological development 11</b></li> <li>- <b>Privacy Risks 7</b></li> <li>- "Useless" Technologies 3</li> </ul>

## Appendix 2. Future opportunities and visions?

Transportation	Energy
<ul style="list-style-type: none"> <li>- <b>Private driving is reduced</b></li> <li>- Integration and expansion of the rail network</li> <li>- <b>Expansion of electric vehicles</b></li> <li>- The importance of artificial intelligence in the functioning of public transport</li> <li>- <b>Joint ownership and business of vehicles</b></li> <li>- Automated public transport</li> <li>- Reduction in logistics costs</li> <li>- Shift of logistics to water and rail transport</li> <li>- Increasing mobility opportunities</li> </ul>	<ul style="list-style-type: none"> <li>- New types of clean energy sources are being developed</li> <li>- <b>Growing popularity of solar energy</b></li> <li>- The use of coal will go down in history</li> <li>- Fusion power plants in fashion</li> <li>- <b>New types of energy preservation solutions</b></li> <li>- Location independence in energy production (natural conditions)</li> <li>- Decentralized power generation</li> <li>- There is a replacement for nuclear power</li> <li>- Water as fuel</li> <li>- <b>Wind power in generalization</b></li> <li>- More efficient harnessing of nuclear power</li> </ul>
Building / Constructions	Long-lasting Products
<ul style="list-style-type: none"> <li>- Transition to wood construction</li> <li>- Energy sources and heating of houses are improved</li> <li>- <b>Artificial intelligence grows in design</b></li> <li>- Energy-efficient construction</li> <li>- The use of "Heat Tech" in construction</li> <li>- Apartments available to all (price and construction costs)</li> <li>- Minimalist house building</li> <li>- Multipurpose furniture</li> <li>- <b>The use of sensors and meters to collect data is becoming more common</b></li> </ul>	<ul style="list-style-type: none"> <li>- <b>Products are developed to be renewable/easier to repair/recyclable</b></li> <li>- Reduction of technology equipment</li> <li>- Replacing plastic with other material</li> <li>- <b>New business from recycling</b></li> <li>- Product prices will drop</li> <li>- Improved software upgradability</li> <li>- "Simplification" of products</li> <li>- <b>Product standardization</b></li> <li>- Transition to modular products</li> <li>- Upheavals in the battery industry</li> <li>- Transition in products from quantitative to qualitative</li> </ul>
Laws and regulations (society)	Food and its production
<ul style="list-style-type: none"> <li>- New (green) fiscal sanctions</li> <li>- <b>Rules and laws related to the life cycle of products</b></li> <li>- <b>Spreading innovations and technologies globally</b></li> <li>- Unification of electronic components</li> <li>- Improving communication between countries and authors</li> <li>- Decision support systems → automation for the best choices</li> </ul>	<ul style="list-style-type: none"> <li>- A revolutionary innovation for intensive food preparation on the way</li> <li>- <b>Laboratory food is becoming more common</b></li> <li>- Automation of agriculture</li> <li>- Food delivery services are becoming more common</li> <li>- Development of meat substitutes</li> <li>- Unhealthy food is abandoned and more consumers are informed about it</li> <li>- <b>Alternative nutrients in the future</b></li> <li>- Increasing vertical farming → developing plant tolerance</li> <li>- Changing eating habits</li> <li>- Closer monitoring of food supply</li> </ul>
Individuals and consumption habits	Education and Jobs
<ul style="list-style-type: none"> <li>- Reduced consumption</li> <li>- <b>Product awareness improves → Choices</b></li> <li>- The importance of price decreases</li> <li>- More accurate monitoring of an individual's carbon footprint</li> <li>- <b>Transition to co-ownership</b></li> <li>- Growing participation in the climate debate</li> <li>- There will be changes in everyday choices</li> </ul>	<ul style="list-style-type: none"> <li>- <b>Education develops and diversifies</b></li> <li>- The growth of IT sectors and the development of teaching</li> <li>- There will be even more jobs</li> <li>- <b>New kinds of training opportunities</b></li> <li>- Virtual learning environments for use</li> <li>- The EU's appeal to work-based change is growing</li> <li>- Transition from heavy work to creative work</li> <li>- Development of "clean" fields of education</li> </ul>
Companies/factories and Businesses	Nature
<ul style="list-style-type: none"> <li>- <b>Commodity production more affordable</b></li> <li>- More business for the waste and recycling side</li> <li>- Raw material-based manufacturing</li> <li>- Business transparency is becoming more common</li> <li>- Sharing know-how and data</li> </ul>	<ul style="list-style-type: none"> <li>- Innovations in water regulation</li> <li>- <b>More focus on natural purification</b></li> <li>- <b>Monitoring the purity of nature on a site-by-site basis with new innovations</b></li> </ul>

- **Artificial intelligence and robots make operations more efficient**  
 - **Marketing as a teacher**  
 - Development of the further processing of textiles  
 - Cryptocurrencies are revolutionizing the market  
 - Alternative materials of manufacture  
 - Manufacturing only for need → Out of the consumer society

### Appendix 3. Who can influence (stakeholders) and how?

European Union (33)	Companies (73)	Production / Factories (29)	Public system (111)	Individuals (11)
EU 33	Companies 15	Factories 8	Government 74	Consumers 7
	Apple 11	Ohjelmoijat 7	Educational faculties 9	Elon Musk 1
	Mega brands 8	Electronic producers 5	City of Oulu 8	Investors 1
	Tesla 7	Electricity producers 3	Sitra 3	Consultants 1
	Construction companies 4	Food production 2	China 2	Marketers 1
	Uber 2	Car producers 2	VR 1	
	Kesko 2	Farms 1	Taiwan 1	
	Logistic Companies 2	Clothes production 1	HSL 1	
	Fast food chain 2	Phone producers 1	Employment Office 1	
	Fairphone 2		Western Countries 1	
	Siemens 1		South-Korea 1	
	Framework 1		VTT 2	
	SolarCity 1		Developing Countries 1	
	Metsä Group 1		ELY 1	
	Google 1		Business Finland 1	
	Swappie 1		Ukraine 1	
	Ebay 1		Russia 1	
	GleSYS-concern 1		ZenRobotics 1	
	Telia 1		India 1	
	Power 1			
	Infinited Fiber Company 1			
	Uber 1			
	SpaceX 1			
	S-Group 1			
	Nokia 1			
	SSAB 1			

**Appendix 4.** Mentioned quotes concepts and interesting technologies / projects that have an impact on a sustainable future.

Pelloilta Pöytään -Strategy	24/7 Society	Right to Repair - Movement
Cleantech	” Put your money there where your mouth is” = Vote with your money	Futuristic Design
Marketing as a teacher	Hyperloop	Trolley Problem
”Corner breaking – attitudes”	Lean and Green	Schumpeters ”creative destruction”
Hydroponic food production	EU:n Green Deal	AI - Governance
Philippines ja ”Axie Infinity”	MOOC thinking and benefits	Jugaad Innovation
Gartnerin Supercurve	ESG: Environmental, Social and Governance	Fast Fashion
Reward system of the public transportation	Electric Receipts	Framework / Fairphone innovations
Renovation Wave		