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Environmental Sustainability through Digitalization in Finnish Public and Private Sector Organizations

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Abstract of master's thesis

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The objective of this study is to understand how different organizations in Finland view digitalization in improving environmental sustainability. There are three research questions. First, it is studied what motivates organizations for environmental sustainability. Second, it is researched how organizations have improved or are interested in improving environmental sustainability through digitalization. Third, it is analyzed what are the differences in motivations, interests and actions depending on respondent positions and organizational characteristics, such as employer sector or industry.

The study consists of a literature review and empirical research on Finnish organizations. Literature is presented on environmental sustainability motivation and on the different direct, indirect and structural effects of digitalization on the environment. The empirical study consists of a survey that gained 249 responses from public and private sector organizations in Finland. The survey covered motivation for environmental sustainability, perceptions on digitalization and sustainability and both actions taken and future interests in different aspects. Digitalization was covered for direct, indirect and structural effects. Environmental aspects included energy, material, waste and emissions.

The results show that respondent organizations were most motivated for environmental improvement by cost savings, followed by reputation, regulation and organizational values or strategy. 90 % of respondents agreed that digitalization and sustainability are highly connected. Furthermore, many respondent organizations have both taken action already and are even more interested in the future about many aspects of digitalization and sustainability. Only around half of the organizations had already taken action to reduce direct environmental impacts of IT equipment, but a large majority were interested in it in the future. Remote work and electronic processes were reported to be used for environmental sustainability already in over 85 % of organizations. Respondents were highly interested in improving environmental sustainability regarding aspects of energy, materials, emissions and waste. 64 % of respondents showed interest in improving three or all four of the aspects. There were rather few differences found between organizational factors.

Keywords Environmental sustainability, sustainable development, digitalization, direct effect, indirect effect, structural effect, environmental aspect, motivation, ICT, organization

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Työn tavoitteena on ymmärtää miten erilaiset organisaatiot suhtautuvat digitalisaatioon ympäristöllisen kestävän kehityksen edistämisessä. Työssä on kolme tutkimuskysymystä. Ensinnäkin tutkitaan, mikä motivoi organisaatioita ympäristökestävyyteen. Toisekseen tutkitaan, miten organisaatiot ovat jo parantaneet ympäristökestävyyttä digitalisaation avulla, ja mistä asioista ollaan kiinnostuneita tulevaisuudessa. Kolmanneksi tutkitaan, mitä eroja on motivaatiossa, tehdyissä toimenpiteissä ja kiinnostuksen kohteissa riippuen vastaajien asemasta ja organisaatioiden luonteesta, kuten työnantajasektorista tai teollisuudenalasta.

Tutkimus koostuu kirjallisuuskatsauksesta ja empiirisestä tutkimuksesta suomalaisille organisaatioille. Kirjallisuutta esitellään ympäristökestävyyden motivaatioista ja digitalisaation suorista, epäsuorista ja rakenteellisista vaikutuksista ympäristöön. Empiirinen tutkimus koostuu kyselystä, johon saatiin 249 vastausta suomalaisilta julkisen ja yksityisen sektorin organisaatioilta. Kysely käsitteli motivaatiota ympäristökestävyyteen, näkemyksiä digitalisaation ja kestävän kehityksen yhteydestä sekä tehtyjä toimenpiteitä ja tulevaisuuden kiinnostusta digitalisaation ympäristöparannuksiin. Digitalisaatiota käsiteltiin suorien, epäsuorien ja rakenteellisten vaikutusten kautta, ja ympäristövaikutuksissa tarkasteltiin energiaa, materiaaleja, jätteitä ja päästöjä.

Tulosten mukaan vastaajaorganisaatiot ovat motivoituneimpia ympäristöparannuksiin kustannussäästöjen, maineen, lainsäädännön sekä organisaation arvojen tai strategian takia. 90 % vastaajista oli samaa mieltä väittämän kanssa, että digitalisaatio ja kestävä kehitys liittyvät vahvasti toisiinsa. Useat organisaatiot ovat jo tehneet paljon toimenpiteitä digitalisaation avulla ympäristökestävyyden parantamiseksi ja vielä suurempi osuus on kiinnostunut aiheesta tulevaisuudessa. Vain noin puolet vastaajista oli tehnyt toimenpiteitä IT:n suorien ympäristövaikutusten vähentämiseksi, mutta suuri enemmistö ilmoitti kiinnostuksesta tulevaisuudessa. Yli 85 % vastaajista ilmoitti, että etätyötä ja elektronisia prosesseja käytetään jo nyt ympäristöparannuksiin. Vastaajat olivat kiinnostuneita parantamaan ympäristövaikutuksia niin energian, materiaalien ja jätteen kuin päästöjenkin suhteen. 64 % vastaajista ilmoitti kiinnostuksensa kolmeen tai kaikki neljään näistä ympäristövaikutuksista. Tulosten mukaan vastaukset erosivat organisaatiotyyppien perusteella toisistaan vähäisesti.

Avainsanat Kestävä kehitys, ympäristökestävyys, digitalisaatio, suorat vaikutukset, epäsuorat vaikutukset, rakenteelliset vaikutukset, ympäristöaspektit, motivaatio, ICT, organisaatio

Esipuhe

Pitkä opintopolku on saatettu päätökseen. Aloitin yliopisto-opintoni syksyllä 2006 informaatioverkostojen ohjelmassa ja suoritin kanditutkintoni kolmen opiskeluvuoden ja yhden asevelvollisuusvuoden jälkeen keväällä 2010. Päätin kokeilla jotain uutta ja suoritin maisterintutkinnon Alankomaissa VU Amsterdamissa monialaisessa Environment and Resource Management -maisteriohjelmassa keväällä 2011. Siitä lähtien olen ollut täyspäiväisesti töissä IT-alalla ja osittain kestävän kehityksen parissa. Siksi halusin vielä suorittaa myös DI-tutkinnon loppuun, kurssi kerrallaan. Tällä matkalla on tullut opittua paljon niin opiskeltavista aiheista, muista ihmisistä kuin itsestä. Lukuisat eri teoriat, menetelmät ja ihmisten kanssa keskustellessa esiintyneet näkökulmat ovat rikastuttaneet omaa ajatteluani valtavasti. Nyt olo on helpottunut ja kiitollinen.

Haluan kiittää professori Eila Järvenpäätä ohjauksesta, valaisevista kommenteista ja kiinnostavista keskusteluista organisaatioiden kestävään kehitykseen ja digitalisaatioon liittyen. Kiitos myös CGI:lle ja Ulla Heinoselle siitä, että sain käyttää yrityksen asiakastietokantaa, verkostoja ja kyselyjärjestelmää aineiston keräämiseksi. Kiitos kuuluu lisäksi niille 249 vastaajalle, joiden vastaukset aineiston muodostivat. Työn tuloksista on toivottavasti hyötyä digitalisaation ja kestävän kehityksen ymmärtämisessä sekä liiketoiminnan kehittämisessä.

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Teemu Meronen, Helsinki, 22. marraskuuta 2017

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1. INTRODUCTION

1.1 Background and motivation

This research is motivated by the desire to study a topic important to the society at large. I want to both understand important trends that are shaping our world and hopefully have a positive impact on the environment and people. When looking at global successes and challenges in the 21st century, it is clear that both digitalization and environmental sustainability have a key role to play.

In this chapter, the importance of environmental challenges is presented, followed by the key role of digitalization in businesses and the public sector. It is then discussed how digitalization can help in environmental impact reductions and how different organizations are more and more interested in improving their environmental performance. The chapter is concluded by discussing whether digitalization's potential in environmental performance improvement is realized in different organizations and how this question motivates the research.

Several studies and institutes argue that environmental challenges are the greatest challenges of our time. For example, climate change is said to be the defining challenge of the 21st century (Rosenthal 2007, Rather 2015). Climate change has already caused more extreme weather events and affected for example the abundances, geographic ranges and migration patterns of multiple terrestrial and marine species (IPCC 2014). In the future, climate change poses a great global threat for example because of sea level rise, more extreme weather conditions, decreasing crops and fish stocks and biodiversity loss (IPCC 2014).

Research suggests that biodiversity will continue to decline over the 21st century, unless processes of human and economic development do not change radically (IRD

2010 & Pereira et al. 2010). The main causes of biodiversity loss are human activities such as degradation and destruction of natural habitats, overexploitation of biological resources and climate change. This environmental degradation can also have a major impact on human well-being and development. For instance, destruction of littoral habitats exposes coasts to more damage from waves, diminishing fishery production and loss of tourism. However, there are possibilities to change current trends. Large scale reforestation, reinforcement of fishing regulations, creating more nature reserves, increasing the efficiency of agriculture and reducing greenhouse gas emissions are ways of reducing human impact on biodiversity. There are great differences in future scenarios depending on human actions. For example, the difference between the most positive and the most negative forest scenarios could mean either a 15 % rise (an area the size of China) or a 10 % shrinkage in the world forest area between 2010 and 2030. (IRD 2010 & Pereira et al. 2010)

Another major trend changing the world is digitalization. Digitalization is expected to change businesses, the public sector and our societies in a profound way. Digitalization is even referred to as another industrial revolution (Caylar et al. 2016). For example, the Internet of Things is changing how goods are made and distributed, how products are serviced and refined, and how doctors and patients manage health and wellness (Manyika et al. 2015). In addition, digitalization is argued to enable improved public sector efficiency and higher value of public services (Jugner 2015).

Digitalization is widely discussed in business, but there is sometimes confusion on whether it is about technology, a new way of engaging with customers or an entirely new way of doing business. According to McKinsey authors Dörner & Edelman (2015), digitalization means three things for businesses: creating value at new frontiers, creating value in core businesses and building foundational digital capabilities. For example, Internet of Things, sensors, and analytics have enabled logistics companies to find new value in data to improve the efficiency of supply chain operations, and car companies to develop new business from self-navigation and in-car entertainment. Similarly as data provides efficiency to supply chains, analytics can deliver insights about customers that drive marketing and sales decisions. For example, websites should remember customer preferences and personalize and optimize the customer experience. Since customers interact with companies more and more through multiple channels, there is ever more data that allows brands to make better decisions about what their customers want. Finally, foundational digital capabilities refer to technological and organizational processes that allow companies to be agile and fast. This means using data as a foundation in making better and faster decisions, lowering decision making to smaller teams and developing iterative processes of continuous improvement. In addition, it refers to transforming systems and data architecture from siloed legacy systems to support connection of devices, objects and people. (Dörner & Edelman 2015)

Digitalization is a phenomenon concerning also the public sector. Dilmegani et al. (2014) note that citizens are expecting government information to be available online in a format that is easy to find and understand with low or no cost. They argue that the public sector should meet these expectations by investing in a comprehensive digital transformation. Authors continue that comprehensive digital transformation goes beyond online services and requires looking for opportunities to improve productivity, collaboration, scale, process efficiency, and innovation. Dilmegani et al. (2014) note, however, that the public sector faces additional challenges with management issues compared to the private sector. These include multiple agencies, a range of organizational mandates and constituencies, longer appropriations timelines, and the challenge of maintaining strategic continuity even as political administrations change.

The Ministry of Finance in Finland (2016) sees digitalization as a trend where people and businesses are in a key role in the development of public services. According to their article, digitalization helps in creating better and more reliable service chains to meet the requirements of good life. For example, intelligent health services can improve welfare of senior citizens, virtual environments can help in learning history and geography and smart public transport may remove the need for a private car in cities. The Ministry of Finance (2016) claims that Finland is one of the leading countries in the world in public electronic services and that the digital skills of Finns are the best in the EU according to numerous studies. Thus, they state that there is a lot of potential for successful public sector digitalization in Finland. Jugner (2015) argues that digitalization can bring major productivity improvements to the public sector. In addition, he claims that high productivity improvement targets should be imposed on the public sector, since only those will cause the necessary redesign of processes. The author continues that there are five organizational changes that could help the public sector use digitalization to improve productivity. First, every member of an organization should be able to connect their own work to the organization's goal. Second, there should be a culture where the middle management and the workers are encouraged to try out new ways of working in practice. Third, there is a need for centralized digital information systems and tools that break silos in organizations. Fourth, there should be clear metrics to which success is measured. Finally, there should be a platform that enables the sharing of best practices within organizations.

Digitalization can also help in the reduction of environmental impacts. Woetzel et al. (2017) report that the consumption of energy is becoming less intense and more efficient as energy-efficient technologies become more integrated in homes, businesses, and transportation. These technologies include energy management systems, advanced analytics and smart grids. There are countless examples where digitalization can help in improving environmental performance in different sectors such as buildings, transport, lighting, foodservices, commerce, design etc. For instance, remote conferencing, collaboration and telecommuting increase the material and energy efficiency of organizations due to travel substitution and less need for office space (Bose & Luo 2011, Jenkin et al. 2011). In addition, electronic processes remove the need for paper processes (Seidel et al. 2013, Jenkin et al. 2011, Fuchs 2008). Moreover, digitalization can improve logistics management, thus reducing material waste in warehouses and travel related emissions, due to analytics and optimization (Bengtsson & Ågerfalk 2011, Molla et al. 2009, Watson et al. 2011). As noted earlier, digitalization refers not just to technology but also to the organizational changes that capture the benefits that technology offers. Nyquist et al. (2016) argue that without rethinking processes, transforming organizations and building new management infrastructure, companies are unlikely to capture much of the value available to them through digital technologies and tools.

Environmental benefits of digitalization should however be compared to the environmental burden that the increasing use of IT infrastructure causes, in order to get the complete picture of the environmental effects. Berkhout and Hertin (2004) suggest looking into three types of effects when analyzing the complete environmental impact of ICT. First, direct effects are the negative environmental impacts caused by the production, use and disposal of IT hardware. The indirect, second-order effects are the ways in which digitalization affects human actions such as improving efficiency of production, dematerialization, detection and monitoring of environmental change etc. According to Berkhout and Hertin (2004), these effects are mostly positive and can lead to improved environmental performance. On the other hand, the positive effects might be reduced due to falling prices for resource inputs and proliferation of smart devices. Structural and behavioral, or third-order, effects of digitalization refer to larger lifestyle and macroeconomic changes that can lead to a less energy and material intensive economy, but on the other hand could stimulate more growth and rematerialization.

Analyzing the total effects of digitalization for society is not easy, but the #Smarter2030 report modeling shows that greenhouse gas emissions avoided through the use of ICT solutions can be nearly 10 times higher than ICT's expected footprint in 2030 (GeSI 2015). These savings are expected in mobility, manufacturing, agriculture, building and energy sectors. Also, Linturi (2016) expects technological innovations to improve environmental sustainability. He lists ten socio-technical innovations of which 4 are enabled by digitalization and have high impacts on either resource efficiency or sustainable development. These innovations are robotic transportation, urban farming, sharing economy and Internet of Things.

Businesses are ever more interested in environmental sustainability and are beginning to understand its strategic importance and innovation possibilities (Esty & Simmons 2011). Nidumolu et al. (2009) state that companies are finding out that environmental sustainability is not a cost for them, but on the contrary a source of innovation. According to a McKinsey survey in 2011, many companies are actively integrating sustainability principles into their businesses for example by saving energy, developing sustainable products and capturing value through sustainability activities (Bonini & Görner 2011). Compared to the previous year's survey, a larger share of executives reported that sustainability programs make a positive contribution to their businesses' short- and long-term value. It is also said that smart companies recognize that issues such as climate change cannot be left only to governments or NGOs to solve (Gunther 2013). Choudhry et al. (2015) state that green thinking and lean thinking are based on the same fundamentals and go hand in hand in many instances. Moreover, the EPA (2017) states that a growing number of manufacturers are realizing the substantial financial and environmental benefits derived from sustainable business practices. They argue that many companies are treating sustainability as an important objective in their strategy and operations to increase growth and global competitiveness. Finally, climate change and other sustainability issues have become a major driver for investor activism over the recent years (Serafeim 2016).

Also, the public sector is engaging in environmental sustainability, both through regulating businesses and through setting goals on their own organizations. In the EU, there is a directive stating that listed companies and other important organizations with more than 500 employees should disclose in their management report relevant information regarding their environmental policies, outcomes and risks (European Commission 2016). In Finland, sustainable development has been on the agenda for a long time. Finland has had a National Commission on Sustainable Development since 1993 and already in 2010, 90 % of real estate management businesses had incorporated energy efficiency activities and 30 % of governmental organizations had an environmental management system (Valtiontalouden tarkastusvirasto 2010). In 2016, the National Commission on Sustainable Development founded the Society's Commitment to Sustainable Development, which specifically notes limits to natural environment and the need for society to adapt to those limits (Valtioneuvoston kanslia 2016). Businesses, institutions, administration, political parties, cities and other actors are invited and encouraged to make their own operational commitments contributing to the implementation of the shared goals. Finally, the commitment states that the public sector should be an enabler and forerunner in environmental sustainability and that opportunities brought by digitalization should be capitalized in a sustainable way.

This research is motivated by the interest in how organizations have used or are expecting to use digitalization in improving their environmental sustainability. This introduction has explained the importance of all of these components. First, it has been shown that environmental problems are important for everyone in the society. Second, it has been demonstrated that the role of digitalization is growing, both in general and specifically in improving environmental performance for businesses and public sector organizations. Third, it has been presented that both businesses and the public sector are interested in improving environmental sustainability.

Despite recent development, it seems that potential of digitalization in environmental performance improvement is not fully realized in many organizations. For example, Manyika et al. (2015) mention many benefits of digitalization in their article, but environmental benefits are not mentioned explicitly. The authors discuss operations management and predictive maintenance regarding factories, traffic control related to cities, routing and autonomous vehicles related to logistics and energy management related to homes. All of these solutions could lead to reduced environmental impacts, but it seems that sustainability does not motivate the author enough to note it as a benefit. Also regarding Finland, Microsoft (2017) discussed 10 things business people should know about Finnish digital transformation, but they did not cover environmental issues at all. Similarly, Caylar et al. (2016) examine possibilities in smart energy consumption, remote maintenance, real-time supply chain optimization, predictive maintenance and advanced process control without covering environmental benefits, even though again all of these technologies have the potential to reduce for example energy consumption, emissions, material usage and waste. Thus, digitalization has the potential to improve environmental performance through improved efficiency and process transformation even if environmental sustainability is not the main motivation. However, it is expected that environmental benefits will be achieved with more certainty if the organizations have high overall environmental orientation (Jenkin et al. 2011) and if top management supports environmental initiatives (Bose & Luo 2011).

This thesis is conducted with the help of CGI Finland Corporation. The data for this thesis was gathered by a survey that was sent to CGI's customers. In addition, the survey was spread in social media by CGI and partner associations. The empirical study completed by me was used both for this thesis and a white paper published by CGI. The white paper was written in Finnish, it is more compact and has more case examples by CGI compared to this thesis. This thesis, on the other hand, is an academic study that has a more thorough empirical analysis and a more extensive literature review.

1.2 Research questions

The objective of this study can be summarized as follows:

> *To understand how different organizations view digitalization in improving environmental sustainability.*

To reach this objective, the existing literature is reviewed and an original empirical study is conducted. The field of this study is in the cross section between management, technology and environmental studies. The literature review includes for example research on organizational theories, management of information systems, environmental management, energy and climate change. In addition, some case studies where digitalization is successfully used in improving environmental sustainability are presented. Moreover, the use of digital technologies in our society causes both positive and negative environmental impacts. There are different estimates and predictions on these impacts that are also compared and discussed.

To make the scope more manageable for the thesis, in the empirical study, the focus is on Finnish organizations, or more precisely organizations that operate in Finland. In addition, the focus is more on the medium-sized and large organization, which are assumed to have more interest in environmental sustainability and digitalization for example due to more resources, higher regulation, and higher customer pressure. (Stanwick & Stanwick 1998, Baylis et al. 1998, Collins et al 2007, Bose & Luo 2011, Hörisch et al 2015)

Before diving into digitalization and how it is used in improving environmental sustainability, it is important to understand if and why organizations are motivated by environmental sustainability in the first place. Thus, the first research question is:

1. *What motivates Finnish organizations for environmental sustainability?*

After gaining a general understanding on the importance of environmental sustainability for the organization, the focus is shifted more into ICT technology usage and how organizations use digitalization to improve their environmental performance. The aim is to understand the relationship between digitalization and environmental sustainability. It is interesting to know organizations’ views on digitalization and the environment, the actions that organizations have taken and their interests in the future. Therefore, the second research question is:

2. *How have Finnish organizations improved or are interested in improving environmental sustainability through digitalization?*

This research question is divided into three parts. First, it is researched what kind of perceptions people in Finnish organizations have on the connection between digitalization and environmental sustainability. Second, the environmental impacts of digitalization are categorized into three types of effects that are direct, indirect and structural and behavioral effects. These types of effects are presented in more detail in the literature review. Respondent organizations are researched based on all three types of effects. Finally, digitalization can have an effect on organizations’ multiple environmental aspects. Environmental aspects are defined in the ISO 14001 environmental standard (2015) as element of an organization’s activities or products or services that can interact with the environment. Environmental aspects relevant to this study are organizations’ energy use, greenhouse gas emissions, material use and waste.

The focus of the empirical study is on Finnish organizations, and the assumption is that the organizations and the people working in them are not homogenous. It seems likely that there are differences between organizations in how digitalization is used and between people in how digitalization is viewed. Therefore, the third and final research question is:

3. *What are the differences in motivation, perceptions, actions and interests depending on organizational characteristics and respondent position?*

For example, people working in the environmental field are experts in their subject matter and thus they might be more motivated also in using digitalization in improving environmental sustainability compared to other people. There could also be differences in perceptions between managers and experts. In addition, there are differences between industries on how important sustainability is to them (Bonini & Görner 2011, Sitra 2015). Thus, it would be reasonable to think that some industries are also more ahead in using digitalization for environmental improvement compared to others. Moreover, since different industries have different environmental impacts, it is assumed, that the industrial classification of organizations might correlate to more or less interests in certain environmental reduction measures.

Figure 1 presents the scope of the study and an overall picture of the different research questions.

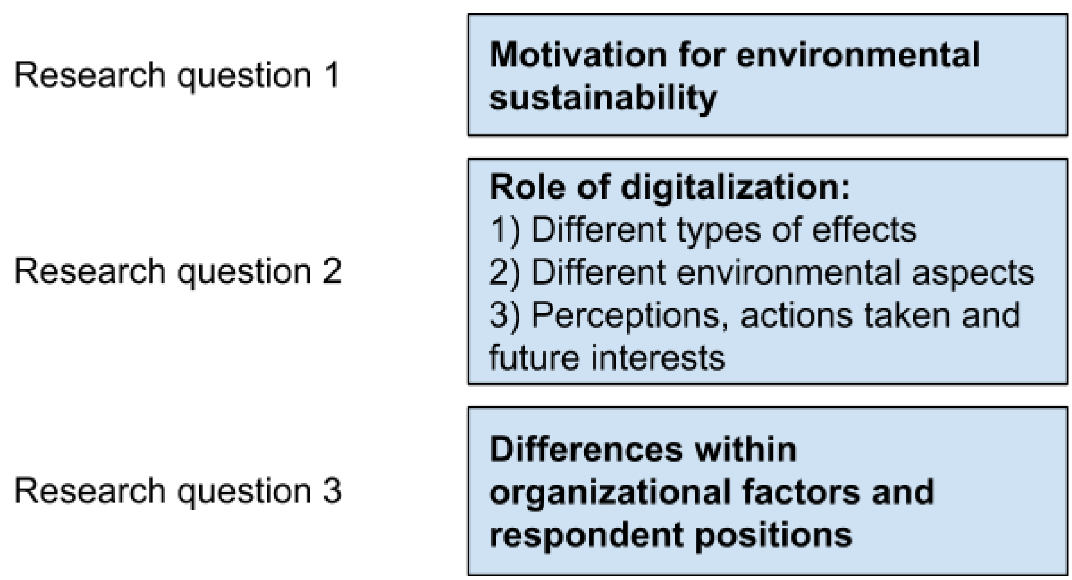


Figure 1. Overall view on the scope and research questions of the study

1.3 Definitions

Environmental sustainability has been a concern for citizens, nations and organizations ever since people have had an understanding of the limitations of our planetary resources, the waste we are producing and other negative impacts that growing human activities have on the natural environment. One of the most widely accepted definitions for sustainability comes from the Brundtland report: *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED 1987, p. 43).

Another popular definition for sustainability is called the triple bottom line, which refers to the bottom line of companies, i.e. their profits, and adding social and environmental bottom lines in addition to the economic perspective (Elkington 1994 & 2004, Slaper and Hall 2011). The triple bottom line is also referred to as the three Ps: people, profit and planet (Kleindorfer et al. 2005)

Daly (1990) looks at sustainability from a natural capital point of view. He divides sustainability into three different perspectives and makes a sustainability statement for each. The perspectives are renewable resources, pollution and non-renewable resources. First, for renewable resources, he states that the rate of harvest should not exceed the rate of regeneration. This is called the sustainable yield. Second, for pollution, the rates of waste generation from projects should not exceed the assimilative capacity of the environment. This is called the sustainable waste disposal. Third, for nonrenewable resources, the depletion of the nonrenewable resources should require comparable development of renewable substitutes for that resource.

In this study, the focus is on the environmental sustainability of organizations and a term environmental performance is often used in this context. Environmental performance is defined as the relationship between the organization and the environment, including the environmental effects of resources consumed, the environmental impacts of the organizational process, the environmental implications of its products and services, the recovery and processing of products and meeting the environmental requirements of law (Environmental Practitioner Programme, 2002).

Combined from the presented literature, the following definition of an environmentally sustainable organization is used in this study:

> *Environmentally sustainable organization is one that minimizes its negative environmental impact and possibly offers environmentally positive solutions to its customers and stakeholders, thus not contributing to compromising of global environmental boundaries or the future generations' needs.*

Digitalization is another key word in this study that needs to be defined. Gartner (2017) IT glossary defines digitalization in the following way: *"Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business."* It is important to differentiate digitalization from digitization, which Gartner (2017b) IT glossary defines as just the process of changing from analog to digital form.

It is interesting to note that the Gartner (2017a) definition of digitalization is quite focused on for-profit organizations. The words revenue, business model and digital business emphasize activities related to profit. However, digitalization can be as present in public sector and not-for-profit organizations, since digitalization can be used to reduce costs, transform processes and to create new value for citizens or other stakeholders. Thus, emphasis in digitalization could be on value producing opportunities in general, rather than focusing on only the business sector.

IGI Global (2017) defines digitalization as larger change: "The integration of digital technologies into everyday life. Digitalization also means the process of making digital everything that can be digitized and the process of converting information into digital format.” This definition includes digitization, and digitalization is just seen as digitization that concerns everything imaginable and daily life.

Comparing the IGI Global (2017) definition to the Gartner (2017a) definition, we see some interesting differences. First, the Gartner (2017a) definition focuses on businesses or at least organizations as the active role doing the digitalization, whereas in the IGI Global (2017) definition there is no active role. Second, the Gartner (2017a) definition focuses on the change that digital technologies will bring, but the IGI Global (2017) definition does not say anything about what digitization of everything will do. Since this study is focused on organizations and the change that digitalization will bring to environmental sustainability, the Gartner (2017a) definition is more usable here.

Relating to digitalization and environmental sustainability, the concepts of Green IT (Murugesan 2008) and Green information systems (IS) (Butler 2011) are commonly used. In addition, concepts of virtualization (Bose & Luo 2011) and the internet economy (Fichter 2003) are discussed in literature relating to digital technologies and environmental improvement.

Murugesan (2008) defines Green IT as “the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment.” He continues that Green IT takes into account economic, environmental and social dimensions such as improved system performance, energy efficiency, recycling, waste management and ethical working conditions. According to Murugesan (2008) Green IT includes numerous activities including the following:

- design for environmental sustainability
- energy-efficient computing
- power management
- data center design, layout, and location

- server virtualization
- responsible disposal and recycling
- regulatory compliance
- environmental metrics, assessment tools and methodology
- environment-related risk mitigation,
- use of renewable energy sources
- eco-labeling of IT products.

This definition focuses on reducing the direct negative impacts that IT infrastructure causes, but does not take into account all the indirect environmental benefits that digital solutions can enable.

Butler (2011) discusses Green information systems (IS). He states that Green IS can be applied to multiple tasks that either inform about environmental impacts, thus helping to reduce them, or directly reduce those negative impacts through optimization and control. The roles of digital technologies include monitoring and reporting on greenhouse gas emissions, controlling and reporting on waste, toxic and hazardous materials use, managing energy-consuming facilities such as transport and building, helping design greener products and helping redesigning business processes across the enterprise so as to be environmentally sustainable.

Bose & Luo (2011) discuss virtualization and the change that it enables by automating business processes. They argue that virtualization is the primary force for organizations to integrate environmental sustainability into business and IT practices. They continue that virtualization advances flattened organizational structures, larger spans of control, and extensive geographically dispersed work. In addition, authors state that IT virtualization enables consolidation of resources, reduces costs for hardware, improves software testing and deployment, reduces energy and physical space use, and increases the flexibility of hardware investments.

Fichter (2003) discusses the role that e-commerce, e-business and the internet economy have on the environment. According to author, the internet economy is based on three key characteristics. First, the economy is founded on digital technologies. Second, the economy is intensively interlinked, and finally, the economy is global. Fichter continues that the internet economy means the networking of economic actors and processes with IT and that it causes changes in value creation, markets, professional life and consumption patterns. E-business and e-commerce are defined as applications in the internet economy. E-commerce is about online sales transactions and e-business is a broader term including also video conferencing and teleworking. E-business is defined as business processes, commercial activities, or other economic tasks conducted over the Internet or computer mediated networks.

In conclusion, the terminology related to environmental sustainability, digitalization and Green IT shows that the topics covered in this thesis are complex and somewhat interdependent. Environmental sustainability of organizations is about individual and group views, and actions relating to renewable and nonrenewable resources, pollution and planetary environmental boundaries. Digitalization, on the other hand, connects technology, new value creation and businesses. Furthermore, Green IT, virtualization, e-commerce and the internet economy are concepts that link digitalization and environmental aspects together.

1.4 Scope of the Study

In general, this study is about the role of digitalization in driving sustainability in organizations. However, a more specific scope need to be established.

First, the focus of this study is precisely on environmental sustainability. The concept of sustainability is sometimes defined to cover the so-called people aspect in addition to planet and profit aspects. Dao et al. (2011) argue that most sustainability research in general and especially sustainability research regarding IT is over-focused on environment and under-focused on people. I agree with Dao et al. (2011) in the view that literature is more focused on environmental sustainability, and that social sustainability of IT is an important research topic, since IT solutions can improve people's access to education and healthcare (GeSI 2015), among other things. However, the scope of this study is on environmental sustainability as the objective is to understand digitalization's possibilities related to planetary boundaries.

Second, the literature review concerns organizations in general, but the empirical study focuses on Finnish organizations or organizations that operate in Finland. In addition, the focus is more on medium and large organizations (more than 250 people), since they are expected to be more concerned with environmental sustainability and invest more into digitalization due to more resources, higher regulation burden and higher customer pressure. (Stanwick & Stanwick 1998, Baylis et al. 1998, Collins et al 2007, Bose & Luo 2011, Hörisch et al 2015)

1.5 Structure of the Thesis

The structure of the thesis is as follows. First, there is a literature review on the motivation for environmental sustainability and how digitalization affects an organization's environmental performance. Second, the methodology of the empirical research is presented. This includes research design, data collection methods and finally data analysis methods. Thirdly, the results of the empirical study are presented and the results are compared to literature where applicable. Next, the main findings and both practical and theoretical implications are discussed. In addition, recommendations for further research are suggested. Finally, the thesis is concluded by conclusions summarizing the results and discussing the limitations, reliability and validity of this study.

2. LITERATURE REVIEW

In this literature review, the focus is on presenting background information on all of the research questions. In other words, it is examined what motivates organizations for environmental sustainability based on theory and on surveys both globally and in Finland. In addition, literature and case examples are presented on how digitalization is viewed and used in improving environmental sustainability, based on different types of effects and different environmental aspects. Moreover, differences in perceptions and actions depending on respondent position and organizational characteristics are also covered within previous topics. The literature review covers surveys and examples of organizations all over the world, but the empirical part focuses on Finnish organizations.

2.1 Organizational Motivation for Environmental Sustainability

2.1.2 Literature on Environmental Motivation

The question of what motivates organizations for environmental sustainability, and more specifically, what motivates using IT and information systems for environmental sustainability, has been researched quite a lot in scientific literature. There are multiple theories and perspectives that emphasize different viewpoints on the motivation topic. I am going to present these viewpoints in the following, and more detailed reporting can be found in Meronen (2016).

There are multiple factors explaining why both businesses and the public sector are motivated to improve their environmental sustainability. For example, Spector (2012) lists 10 reasons why companies should care about sustainability. First, sustainability can imply cost savings, since it improves energy efficiency and reduces waste. Second, there is increasing consumer demand for more sustainable products and services. Third, sustainability improves risk mitigation related to volatile energy prices and costly environmental accidents. Fourth, some leading companies embrace sustainability and do more than regulators demand since they want to be a part of the conversation on environmental policy. Fifth, in some countries, governments offer a range of financial incentives for undertaking environmentally responsible activities. These include investment-, production-, or consumption-based tax credits, tax exemptions and cash grants. Sixth, more and more employees want to work in a company where sustainability is embedded into the corporate culture. Seventh, many companies see that sustainability initiatives generate brand value and improve a company's image. Eighth, improving sustainability protects from resource limitations. As scarcity increases, cost also increases and firms need to find alternate resources for their products and services. Ninth, sustainability is necessary for keeping up with the competition. A survey made in 2010 by MIT Sloan Management Review for nearly 3000 global executives found that around two-thirds of respondents believed sustainability was necessary for being competitive in today’s market (Haanaes et al 2011). Finally, sustainability can bring new revenue opportunities through innovations. When companies start to incorporate reduction of natural resources, mitigation of climate change and energy transition into their innovation process, there is more drive for new business models, products and services.

Many motivations for environmental sustainability are applicable for public sector organizations in addition to businesses (Cisco 2009, London 2012). While private and public sector sustainability efforts differ somewhat, there are substantial commonalities among most organizations that are pursuing sustainability, and it seems that the overarching idea of sustainability is fairly commonly understood (London 2012). Pressure for cost reduction, demand from stakeholders, risk mitigation, government policies, employee retention and organizational image all are factors that affect businesses and the public sector alike. In addition, the Global Reporting Initiative (2012) states that public sector organizations have a civic responsibility to manage public goods, resources and facilities in a way that supports sustainable development objectives and promotes the public interest. They continue that public sector organizations are central to the delivery of sustainable development, since they have a major role in shaping how people live their lives through education, environmental services, planning and social care. In addition, Stritch & Christensen (2014) suggest that public service motivation within public sector employees is linked to motivation towards environmental sustainability. On the other hand, revenue, profit and competition are terminology that might not be that relevant in the public sector, so motivations related to these should not be relevant in public sector discourse.

Institutional theory has been used for example by Chen et al (2008), Rika (2009) and Butler (2011), and it focuses solely on external pressures motivating organizations for sustainable practices. Institutional theory looks into influences that shape social and organizational structures, schemas, rules, norms, routines and ultimately the behavior of social actors (Scott, 2004). In other words, institutional theory explains why organizations that have started out differently may over time start to behave similarly. The external pressures in the theory are categorized by DiMaggio and Powell (1983) into mimetic, normative and coercive pressures. Authors define mimetic pressure as uncertainty-coping strategy where organizations conform to each other's behavior. Acting similarly to other organizations is thus seen as reducing uncertainty relative to them. Normative pressure is defined as cultural expectations pressing organizations into acting in a legitimate way. Coercive institutional pressure is defined as governmental laws and regulations that drive organization to act in a similar way.

Bose & Luo (2011) have developed a framework that uses three well-established information system theories - technology-organization-environment, process-virtualization, and diffusion of innovation - in identifying the factors that are used in assessing a firm’s readiness to improve sustainability through IT enabled virtualization. They categorize different factors into technological, organizational and environmental contexts. They divide technology readiness further into sensory readiness, relationship readiness, synchronism readiness and identification and control readiness, and say that all of those will positively influence Green IT initialization. Bose & Luo (2011) focus mainly on virtualization, meaning for example teleconferencing or virtualization of business processes. This perspective covers some but not all aspects included in the overall definition of Green IT. Authors cite numerous articles showing that the top management's commitment and support is important in orchestrating the organizational adaptations in technology, strategy, and business processes. On the other hand, lack of managerial support for change management leads to unsuccessful organizational adaptations. In addition, managerial support has been found important related to e-business initiation, adoption, and routinization. In addition to legislation coercing organizations to Green IT, regulatory support may improve diffusion of innovation. Thus, regulation can improve environmental performance in one country compared to others. Finally, authors propose that higher competition intensity leads to a more probable Green IT initiation. The argument is that innovation diffuses through the market as competitors imitate each other's best practices. They continue that staying ahead of the regulatory curve might be beneficial for the companies, as they have more control compared to a strategy of just reacting to regulation. (Bose & Luo 2011)

Another perspective comes from the multilevel theory developed by Jenkin et al. (2011) that includes five motivating forces that influence environmental sustainability strategies: organizational, regulatory-market, socio-cultural, ecological, and technological. Authors define technological forces as the technologies available that facilitate environmentally sustainable business practices, for example, energy efficient chips. However, they argue that according to broader literature, technological forces are not as important as other factors in determining organizational behavior related to sustainability. Organizational forces are internal to the organization and reflect leadership, internal stakeholders (including employees), capabilities, structures, policies, and financial considerations. Market and regulatory forces reflect the demand for sustainable solutions from the customers and laws through regulation. Even without a direct market reaction there is need for social legitimacy in organizations that socio-cultural factors can encompass. For example, media and other public pressure can play a significant role in moving organizations towards more sustainable business practices. Ecological forces reflect the fact that the amount of impact that deterioration of natural resources has on an organization might affect how much the organization is interested in making its own operations sustainable. For instance, the service industry might not notice ecological deterioration as clearly as the manufacturing industry that sees diminishing resources more directly. (Jenkin et al. 2011)

In conclusion, there is a lot of literature on the motivation of both the public and private sector regarding environmental sustainability. In addition, there are a lot of theories on the motivation and factors for using information technologies and systems for environmental sustainability. Views in different theories are similar in many ways, but they also offer somewhat differing perspectives. In general, there are both internal and external motivating factors regarding organizational sustainability. Internal motivations include employees valuing sustainability, and organizational strategies, values and policies supporting it. External factors include technology availability, fierceness of competition, ability to mimic competitors, regulation, norms and direct impacts of environmental degradation to organization. In the next section we are going to look into empirical studies on the motivation for environmental sustainability.

2.2 Empirical Surveys on Environmental Motivation

There are many global surveys for organizations on what their motivations for sustainability are. McKinsey did a global online survey on sustainability in 2011 that was open from July 12 to July 22 and received a total of 3,203 responses from executives around the world representing different industries and company sizes (Bonini & Görner 2011). According to the survey, 33 % of the respondents reported that their companies' top reasons for addressing sustainability included improving operational efficiency and lowering costs. This was the most frequent choice in the 2011 survey and its importance had increased substantially from 2010, when it was top choice for only 19 % of the respondents. The second most frequent reason chosen was reputation with a value of 32 %, the third most frequent choice was alignment with the company's business goals, mission, or values, with a value of 31 %, and the fourth most popular answer was new growth opportunities with a value of 27 %. The McKinsey global survey authors Bonini and Görner (2011) conclude that compared to previous years, respondents reported a more well-rounded understanding of sustainability and its expected benefits. In addition to reputation, respondents expected operational and growth-oriented benefits in the areas of cutting costs and pursuing opportunities in new markets and products. Authors continue, that when it comes to differences between industries, energy, the extractive industries and transportation are more active in the field of sustainability compared to other sectors, probably due to more regulation and natural-resource constraints in those industries. (Bonini & Görner 2011)

MIT Sloan Management Review conducted a survey on innovation and sustainability in 2010 that gathered nearly 3,000 responses from executives and managers from organizations all over the world, covering every major industry and organization sizes ranging from under 500 to over 500,000 employees (Haanaes et al 2011). The survey showed that companies recognize the brand building benefits of sustainability and these benefits were the highest rated by the respondents. In addition, the respondents generally agreed that sustainability is important for remaining competitive. Furthermore, there was a consensus that sustainability brings benefits in resource efficiency and waste management. However, there were also some differences between respondents. In the study, authors divided respondent organizations into two broad groups depending on their attitude towards sustainability: cautious adopters and embracers. In short, both groups of companies view sustainability as eventually becoming part of the core business, but the sustainability embracers have already embedded sustainability in their strategies and operations. The survey showed that cautious adopters view the sustainability business case in terms of risk management and efficiency gains. Embracers, on the other hand, view sustainability in broader terms of employee engagement, innovation, stakeholder appeal, process improvement and growth opportunity. Even though intangibles such as innovation, employee engagement and stakeholder appeal are valued by the embracers, they still find these benefits hard to measure. All in all, the study concluded that embracers are implementing sustainability driven strategies widely and are more successful than cautious adopters in making robust business cases for their investments. (Haanaes et al 2011)

The Economist Intelligence Unit (EIU 2009) conducted a global online survey on assessing the importance of sustainability to corporate strategy in 2009. The survey was open between August and September and received 183 responses. Despite the smaller number of respondents, also this survey covered all major regions of the world, and industries including financial services, professional services, energy and natural resources and healthcare, pharmaceuticals and biotechnology. Respondents also came from a broad range of functions, including strategy and business development, general management and finance. Firstly, 78 % of respondents said sustainability initiatives are very or somewhat important to their current business strategy. In addition, 87 % of respondents see them as very or somewhat important to future growth. This study also divided the respondent organizations into two groups: sustainability leaders and others. The leader group, 27 % of the respondents, were formed out of those that themselves reported their organization to be above average in all of the survey's sustainability-related categories: the ability to integrate initiatives into core strategy, investment in initiatives, and reputation among stakeholders. Members of this sustainability leaders group of companies reported better than average results in non-sustainability areas as well. When it comes to motivation for sustainability, the fundamental difference between the groups of sustainability leaders and others is that leaders have a greater conviction that business benefits will arise out of sustainability initiatives. Results of the survey are presented in figure 2. (EIU 2009)

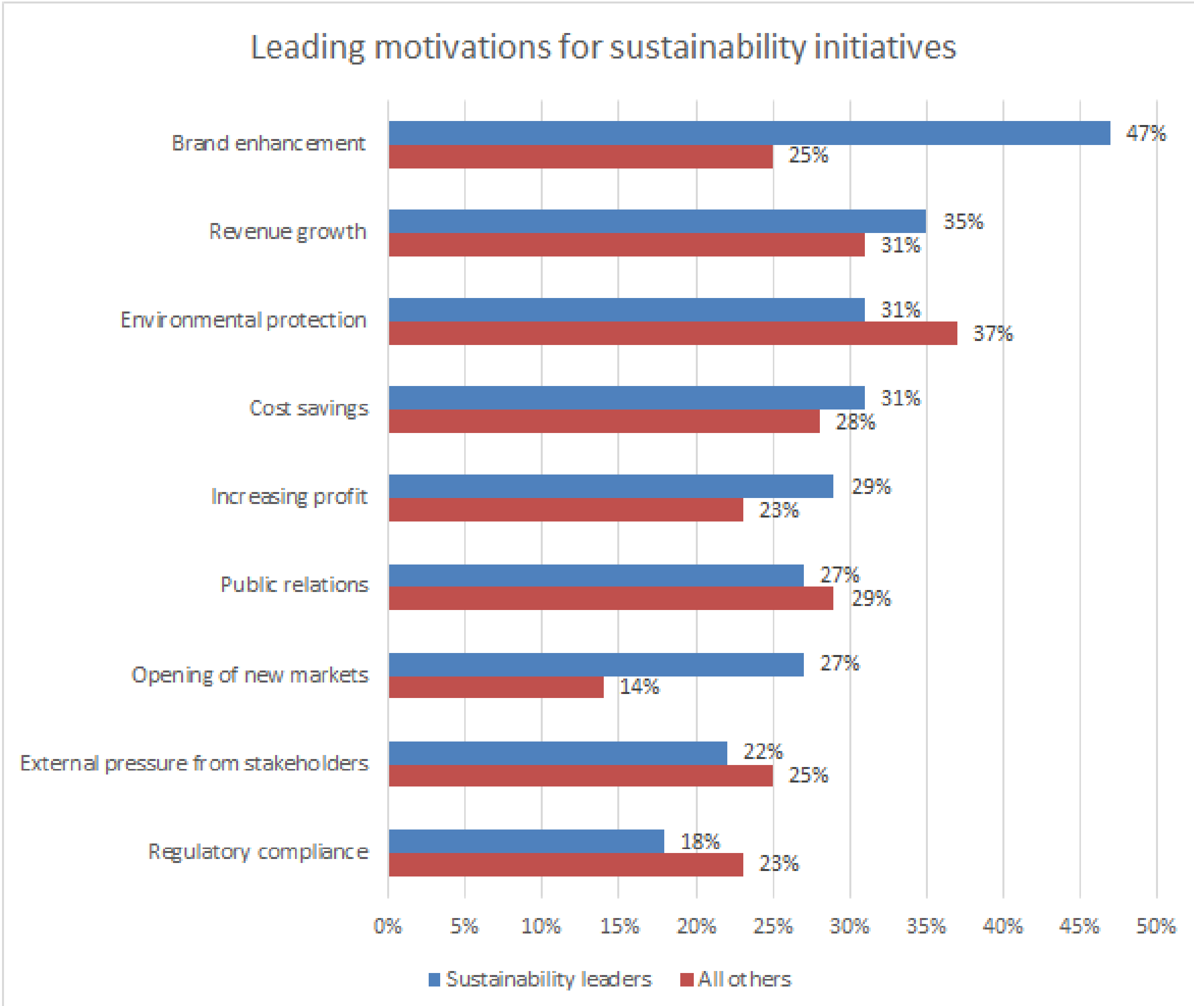


Figure 2 Leading motivations for sustainability initiatives. Source: Economist Intelligence Unit survey, September 2009

Figure 2 shows that sustainability leaders and others have a different set of leading motivations for sustainability. Leaders are motivated very strongly by brand enhancement with 47 % citations and somewhat by revenue growth (35 %), cost savings (31 %) and environmental protection (31 %). Interestingly, other companies cite environmental protection most (37 %) as their leading motivation for sustainability. The EIU analyzes that while environmental protection is a respectable motivation, it is not directly related to core business and thus it might lead to fewer investments in sustainability. The study continues that, in general, leaders tend to be driven more by business-focused motivations and others more by external drivers such as regulation and outside pressure. The EIU concludes by stating that to be good in sustainability, companies must find the related business benefits. (EIU 2009)

There have also been some relevant studies closely related to environmental sustainability conducted in Finland. Firstly, Finnish Business & Society (FIBS), the leading non-profit corporate responsibility network in Finland, has conducted a yearly survey where they ask both why companies are investing in corporate responsibility and what their drivers for corporate responsibility are (FIBS 2016). Corporate responsibility includes environmental sustainability, but it is a larger topic and it includes also themes such as social responsibility (BusinessDictionary 2017). It should be noted that Lynes & Andrachuk (2008) argue that there are differences between motivations for social and environmental responsibility. Secondly, Sitra, Finland's fund for the future, published a study in 2015 about Finnish companies and carbon neutrality (Sitra 2015). In the study, companies were asked about the main drivers for carbon neutrality. The term driver is very close to the term motivation and carbon neutrality is a specific form of environmental sustainability concerning only climate change.

FIBS (2016) conducted its fourth annual corporate responsibility study as a phone interview between December 9th of 2015 and January 22nd of 2016. The study had 202 participants comprising of CEOs (56 %) and corporate responsibility leaders (44 %) from Finnish top 1,000 companies. 90 % of participating companies responded that the importance of corporate responsibility is growing, but the resources for it are not increasing at the same pace. Each respondent could choose three most important motivations for investments in corporate responsibility. Respondent choices can be seen in figure 3. (FIBS 2016)

Figure 3. Why respondent organization invests in corporate responsibility. Source: FIBS 2016

The FIBS study (2016) concludes that the building of corporate image is the most important reason for investing in corporate responsibility. They also note that the very low motivational aspect of new innovations shows that companies do not see climate change or other societal problems as business opportunities or as starting points for creating new products and services. The study also asked about main driving forces behind corporate responsibility actions. Respondents could pick up to three most important driving forces from the choices: top management, customers, owners and investors, employees, regulators, middle management, NGOs, employer organization and labor unions. Top management was the main driving force for 75 % of the respondents (90 % in 2015). Customers were the second most important choice with a score of 59 % (51 % in 2015) and owners and investors had third place with a score of 58 % (52 % in 2015). Employees and regulators were the next most important driving forces, but both of these were chosen by less than 50 % of the respondents. The report concluded that the influence of customers and investors is growing. More companies than before told that they measure corporate responsibility results through customer satisfaction. In addition, share price was an expected benefit of corporate responsibility investments for a growing number of respondents. The study also revealed that 62 % of respondents (57 % in 2015) saw corporate responsibility as very important for their business. FIBS analyzed that this increase from 2015 indicated that long-term thinking is increasing in companies in addition to short term profitability goals, despite the long stagnation in Finland. Finally, the study showed that corporate responsibility actions are increasing, and for example responsibility management practices are more important than before. For example, almost 70 % of companies have ethical guidelines and every third company includes corporate responsibility indicators as part of their leader and employee bonus system. (FIBS 2016)

Sitra (2015) conducted a survey on carbon neutrality in organizations, and one of the questions concerned main drivers for carbon neutrality. The responses were gathered between December 2014 and January 2015. Over 500 managers or experts from Finnish businesses in different fields participated in the study. Respondents rated the importance of each driver for carbon neutrality from 1 to 5, where 1 indicates not at all important and 5 indicates very important. The average score for each driver is shown in figure 4.

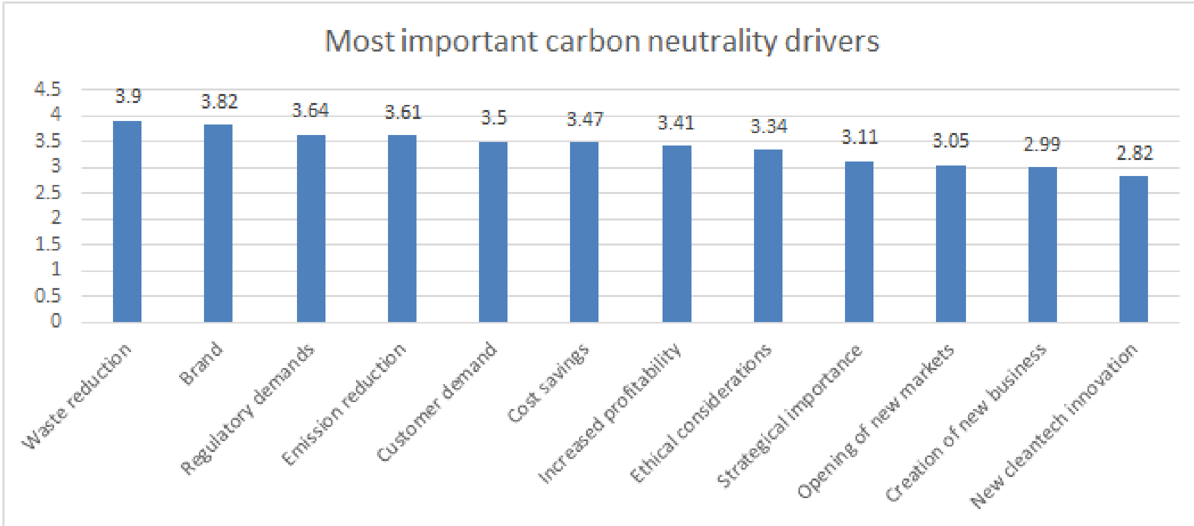


Figure 4. Most important carbon neutrality drivers. Source: Sitra 2015

The three most important drivers according to the Sitra (2015) survey were waste reduction, brand and regulatory demands. According to Sitra, it was surprising that new cleantech innovation was regarded as the least important driver. Sitra also noted, that while most companies thought that carbon neutrality is an important source of strategic competitiveness, only a quarter of companies were measuring their own greenhouse gas emissions, and only a tenth of the companies have set a carbon neutrality goal. The study revealed that 83 % of the respondents thought that climate change is an important factor in their business now or in the future. In addition, 75 % of the respondents thought that carbon neutrality is an important strategic theme for them now or in the future. When looking at different business sectors, especially energy, environmental, forest and paper industries found carbon neutrality important. Carbon neutrality was least important for the metal industry. (Sitra 2015)

In conclusion, there are a lot of studies regarding organizational motivation for environmental sustainability. Results differ somewhat depending on the motivation choices presented, time and scope of the studies. Nevertheless, there are significant similarities in the studies. Three factors that seem to come up within the motivations in most of the studies are, first, reputation or brand, second, cost, efficiency or competitiveness, and third, values, goals or business fundament. In addition, growth opportunities or future prospects are mentioned quite often, as well as regulation. Differences between industries or other organizational factors were not covered in most of the studies. However, it seems that energy, manufacturing and other environmentally intensive industries are more concerned about sustainability, probably due to higher regulation and closeness of the issue to their business (Bonini & Görner 2011, Sitra 2015). Finally, some studies divided respondents into leaders in sustainability and others, and found interesting differences. It seems that, in general, organizations view environmental sustainability as a risk management and efficiency issue, and are more motivated by external drivers such as regulation and outside pressure. Sustainability leaders, on the other hand, view sustainability in broader terms, and are more driven by internal motivation and business focus.

2.3 Sustainability through Digitalization

2.3.1 Types of effects

Digitalization and different kinds of IT solutions can have multiple types of environmental effects that can be either positive or negative. For example, remote work made possible through digital collaboration tools can reduce energy consumption and emissions related to travel. On the other hand, increasing amounts of laptops and data centers need material and energy, and produce hazardous waste. Thus, there is a need for a way to categorize and analyze these different kinds of impacts. (Berkhout and Hertin 2004)

A useful division of the different environmental effects has been developed by Berkhout and Hertin (2004) and used in other studies (e.g. Fichter 2003, Bittinger 2008). This categorization divides the environmental impacts to three different types of effects that are:

1. *The direct effects of IT*
2. *The indirect effects of IT*
3. *The structural and behavioral effects of IT*

Direct, first order effects are the negative environmental impacts caused by the production, use and disposal of IT hardware. This IT hardware can be for example end-use devices, servers or network cables. According to Berkhout and Hertin (2004), first order impacts of IT devices are not very different from the environmental effects of many other products, but they do bring out several specific problems with regards to resource use, emissions and waste management.

The indirect, second-order effects of IT are seen as predominantly positive. Firstly, IT can make production more efficient. For instance, different kinds of tools and sensors can help with design, collaboration, control, production speed and scale. Secondly, IT can dematerialize a variety of the products that we currently use. For instance, paper contracts are becoming more useless each passing day, as they are continuously replaced by electronic contracts. Another example of dematerialization is streaming services that make physical products useless in the listening of music, watching of videos and other similar media. In some cases, however, the digital products may be additional to conventional products, and this increases the overall environmental impact. (Berkhout and Hertin, 2004)

Structural and behavioral effects, or third order effects of IT, relate to more fundamental processes of change and can have both positive and negative outcomes, according to Berkhout and Hertin (2004). Some examples of positive effects include moving from an industrial economy towards a service economy, as well as IT’s role in changing people and organizations to favor and demand products that are more environmentally friendly. However, there are some potentially negative environmental effects due to what is known as the rebound effect. The rebound effect happens when efficiency improvements cause a growing demand that either reduces or even negates the positive environmental impact originally achieved by the efficiency improvements.

The rebound effect has been the topic of an extensive amount of research (Freire-González 2010, Sorrell 2007, Antal & van den Bergh 2014). A concrete example of the effect could be imagined in a case of CD albums and flights. In this example, people replace their CD albums with a streaming service thus reducing their environmental impact and the amount of money they spend on music. The essential question is how that saved money is then spent. If it is spent on an activity that is more environmentally consuming, such as flying to a faraway destination, the overall environmental impact may actually increase. Energy and transport are examples of sectors where the rebound effect has often been observed (Berkhout and Hertin 2004).

Berkhout and Hertin (2004) note, that their categorization does not do justice to the role of information technology in the shaping of knowledge and awareness about environmental issues, or in enabling responses to recognized problems. These impacts could however be argued to be a part of both the second and the third order effects of IT. As IT helps in understanding both its own and other environmental impacts, it can cause positive indirect and structural and behavioral effects in the entire society.

These three types of effects - direct, indirect, and structural and behavioral - are used in the rest of the study to understand why and how digital solutions can have both positive and negative environmental impacts.

In conclusion, achieving sustainability through digitalization in organizations requires the following:

1. *minimize the negative direct impact of IT equipment and infrastructure*
2. *utilize efficiently the positive indirect effects of digitalization*
3. *extend the positive effects of structural and behavioral effects of digitalization, and tackle the rebound effect*

2.3.2 Direct Environmental Effects and How to Reduce Them

ICT infrastructure and other electrical and electronic equipment cause multiple direct impacts on the environment: manufacturing of equipment requires material and energy, using them requires electricity that produces greenhouse gas emissions and disposing of them causes waste (Berkhout and Hertin 2004). It is estimated that roughly 50 million tons of e-waste is produced worldwide every year, which amounts to about 5 % of all municipal solid waste (Blau 2006, Lewis 2013). In addition, communication networks, personal computers, and data centers were estimated to use a 4,6 % share of total electricity use worldwide in 2014 (Van Heddeghem et al. 2014). On the other hand, based on actual energy efficiencies realized between 2008 and 2012, and assuming a positive scenario, the ICT sector's emissions in 2020 would be only 2,7 % of global emissions and even decrease to 1,97 % by 2030 (GeSI 2015). Organizations should reduce the direct environmental impacts of ICT by implementing policies aiming for sustainability in the procurement, use and disposal phases (Mingay 2007, Agrawal & Agrawal 2012). There are significant opportunities for efficiency improvements and more sustainable practices regarding multiple environmental aspects and multiple devices including data centers (Mingay 2007, Agrawal & Agrawal 2012).

Operating ICT infrastructure and equipment takes up a significant amount of electricity globally (Van Heddeghem et al. 2014). Estimations vary depending on the year and scope of the studies (Van Heddeghem et al. 2014, Peterson 2013, Fettweis & Zimmermann 2008). Van Heddeghem et al. (2014) calculates that the consumption share of communication networks, personal computers and data centers of total worldwide electricity use rose from 3,9 % in 2007 to 4,6 % in 2012. According to Peterson (2013), the estimates vary depending on whether equipment such as mobile phones, TVs and radios are included in ICT in addition to PCs, networks and data centers, but he concludes that the total share for all ICT is roughly between 4 to 8 percent of global electricity consumption. Van Heddeghem et al. (2014) estimate that all ICT consumed a 9 % share of global electricity in 2012, but note that their approximation is quite rough. Moreover, in North America, Western Europe and Japan, ICT was estimated to consume even 10 % of electricity already in 2008 (Fettweis & Zimmermann 2008).

Energy consumption is closely related to GHG (greenhouse gas) emissions (Vereecken et al. 2010). Thus, energy used for manufacturing and operating IT infrastructure will in general produce a significant amount of greenhouse gas emissions up until the electricity and whole energy sector transforms towards a carbon neutral and sustainable industry. The Kyoto protocol stated 6 major GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), HFCs, and PFCs. These GHGs all have a different global warming potential (GWP) considered for a hundred years horizon. GWPs are expressed relative to the GWP of carbon dioxide in CO_2 equivalent (CO_2eq). For example, methane has a GWP of 25, which means that an emission with 1 parts per million by volume (ppmv) of methane is equivalent to an emission with 25 ppmv of carbon dioxide. The energy consumption of ICT equipment in the use phase is exclusively in electricity consumption. The CO_2eq emissions per kWh vary depending on the country or region where the electricity is produced. For example, in Australia the electricity emissions are approximately 875 g CO_2eq/kWh while in Iceland the emissions are nearly zero. This is due to the different technologies used for energy production. Coal and gas installations emit typically between 800 and 950 g CO_2eq/kWh, while nuclear power and renewables such as hydro, solar and wind do not emit GHGs in the use phase. (Vereecken et al. 2010)

There is also some variety in expected growth rates of ICT electricity consumption in the future. For example, Pickavet et al (2008) projected a 12 % annual growth rate for data center electricity consumption between 2007 and 2020, and even continuing growth rates of up to between 16 and 20 percent were suggested by Fettweis &

Zimmermann (2008). However, only 4,4 % annual growth of ICT electricity consumption was estimated between 2007 and 2012 by Van Heddeghem et al. (2014). On the other hand, authors still estimated that electricity consumption of all three individual ICT categories - communication networks, personal computers and data centers - grew faster (10%, 5%, and 4% respectively) than the worldwide electricity consumption in the same time frame (3%). According to the #Smarter2030 report, with right policy decisions and business initiative, it is possible to decrease the relative share of ICT electricity consumption and emissions (GeSI 2015). Van Heddeghem et al. (2014) argue it is very difficult to predict future growth rates since, on one hand, the amount of data is exploding, the world is getting more connected, and more people in developing countries are able to buy ICT equipment, but on the other hand, mobile devices consume far less energy compared to desktops that are not so popular anymore, data centers can be energy optimized significantly, and smart grid solutions can manage the energy demand of refrigerators and other equipment. They note that frequent estimates of the worldwide electricity use of ICT will be essential to provide timely feedback whether ICT electricity consumption remains relatively small or if it continues to grow at an unsustainable rate (Van Heddeghem et al. 2014).

In addition to operating of ICT equipment, also their manufacturing causes multiple environmental impacts. For example, the production of semiconductors causes significant air emissions (acid fumes, volatile organic compounds and doping gases), water emissions (solvents, cleaning solutions, acids, metals) and wastes (silicon, solvents). Estimates on the energy use of manufacturing vary quite significantly, depending on assumptions and methods used. When looking at all ICT infrastructure and equipment, Pickavet et al. (2008) estimate, that the complete life cycle consumes roughly 50 % more primary energy compared to the use phase. Williams (2004) argues that life cycle energy use of a desktop computer and screen is dominated by production (81%) as opposed to operation (19%). When focusing on laptop computers, Deng et al. (2011) argue that the manufacturing phase represents 62 % to 70 % of total primary energy of manufacturing and operation. They compare their results to a study commissioned by the European Commission as part of development of the Energy using Products (EuP) Directive, that argues use phase to be the dominating factor with 74 % of the total life cycle energy consumption of laptops (IVF Industrial Research and Development Corporation, 2007). Deng et al. (2011) note that the difference in results comes from three factors. First, their study uses a lifetime of 2,9 years, while the EuP study uses 5,6 years. Second, there is a methodological difference, in that the EuP study uses a pure process-sum analysis, which excludes many processes according to Deng et al. (2011). Latter researchers also estimate the contribution of chemicals production, manufacturing equipment, and production of parts and components such as passive devices and disk drives. The third difference is in the sources of data and the level of aggregation of materials and components. Deng et al. (2011) argue, that their direct disassembly method is much more specific than the component level energy intensities used by the EuP study.

Teehan and Kandlikar (2012) researched differences in life cycle assessment (LCA) studies of desktop personal computers. Their results of 9 different studies strongly suggests, that regarding primary energy demand, the use phase is the dominant life cycle phase, and manufacturing impacts are smaller but substantial, while transportation and end-of-life impacts are much smaller. The authors claim, that each of the few LCA studies that report manufacturing impacts as being greater than use-phase impacts, make unrealistically low assumptions regarding use-phase energy consumption. They continue, however, that different studies are very difficult to evaluate, since a full listing of data, methods, and assumptions used is rarely available, mostly due to confidentiality or proprietary data, and the correctness of the data may itself be difficult to determine. They note that data is often reused as newer studies build on older studies, and there is a risk that error might be showing in several studies, and even that false results become established facts. Deng et al. (2011) note, that different views on the importance of the manufacturing phase compared to the use phase lead to different conclusions for policy: should policy measures focus mostly on use phase electricity conservation, such as energy standards and end use education, or should manufacturers be mandated to improve their production practices? They argue that governments should pay extra attention to what kind of consultancy reports they base their policies on. Thus Deng et al. (2011) claim that there should be mandatory sections on previous literature, methods and uncertainty analysis, in order to improve the policy decisions.

ICT infrastructure and equipment also require materials, and after the use phase those materials need to be recycled or they will produce waste. A UN University report estimated, that in 2014 the amount of discarded electrical and electronic equipment was 41.8 million tons. According to the report, around 60 % of the total amount was discarded kitchen, laundry, and bathroom equipment (Baldé et al. 2015). Personal ICT devices — such as mobile phones, personal computers, and printers — accounted for 7% of e-waste. The report also estimated, that the e-waste represented some 52 billion US dollars' worth of potentially reusable resources such as iron, copper, gold, silver, aluminum and palladium. The report refers to this resource opportunity as "urban mine", but notes also the threat of "toxic mine", as e-waste includes hazardous substances such as mercury, cadmium, chromium, and ozone-depleting chlorofluorocarbons. These hazardous substances should be — but too seldom are — managed with extreme care. According to the report, less than one-sixth of e-waste is estimated to have been properly recycled or made available for reuse. (Baldé et al. 2015)

Different organizations can reduce the direct environmental impacts of their ICT equipment and infrastructure in multiple ways, but it is a transition that takes both time and investments (Agrawal & Agrawal 2012). Environmental performance can be improved in different types of equipment, in different life cycle phases and for multiple environmental aspects. Mingay (2007) argues that organizations should have a policy stating what environmentally sustainable ICT means to the enterprise, and a high-level environmental assessment of the enterprise, its supply chain, products and services, as well as the assessment of the IT infrastructure impact. Agrawal & Agrawal (2012) agree, saying that the first step for an organization would be the assessment of the environmental performance of the existing ICT infrastructure, and setting goals on what performance is wanted in the future. Authors note that ICT is a large concept and needs to be divided into multiple parts, e.g. data centers, desktops and laptops fleet, networking equipment etc. They continue, that organizations can get audits to determine the power consumption of each part, and check the compliance of the green standards like ROHS.

Mingay (2007) states, that the life cycle perspective is particularly important in reducing the direct impacts of ICT, demanding consideration or stewardship from cradle to grave of those things over which the enterprise could reasonably be considered to have influence or choice. This perspective reaches beyond energy efficiency and addresses a broad range of environmental issues facing ICT. He continues that organizations need procurement guidelines about choices of suppliers based on their environmental performance, and that of their products and services. In addition, IT departments need to plan for device disposal already at the time of acquisition.

Agrawal & Agrawal (2012) also note that procurement should look into the life cycle costs of ICT, rather than focusing on purchase price. They continue, that organizations need to take into account running, maintenance and disposal costs. Sustainable purchasing concerns everything from desktop motherboards, hard drives and network switches to a laser printer’s toner cartridges. Authors advise that request for proposals can have requirements regarding energy consumption and allowed chemicals. Furthermore, it is important to take care of the ICT equipment after use phase in order to reduce waste. If the organization does not have the expertise to dispose of the equipment in a sustainable way, there are multiple vendors who specialize in e-waste management. (Agrawal & Agrawal 2012)

ICT device energy efficiency represents an easy and significant opportunity for improvements through the application of basic good practices (Mingay 2007). It is estimated that potential power, cost and CO_2 emission reductions of 50% compared to current levels are available through best practices in the use phase. In addition to organizations creating policies for best practices, different types of power management tools can help better understand the potential for savings, support the enforcement of those policies and reduce energy consumption without compromising security and desktop support. Even though the tools are important, it should be recognized that much of the challenge and the solutions will be behavioral. Furthermore, it is important that ICT organization efforts connect to a wider enterprise environmental program to truly deliver substantial and sustained change. (Mingay 2007).

Electricity consumption of data centers is becoming an ever more important factor in the ICT infrastructure business, and luckily there are many ways to improve efficiency (Motiva 2011). For example, data center energy efficiency improvements include optimizing the cooling systems, energy efficient equipment, capturing the waste heat energy for usage and virtualizing and optimizing the servers. Cooling can be optimized by increasing the allowed temperature, separating hot and cold air flows from each other, and depending on the outside temperature, using outside air for cooling. Capturing the waste heat energy for usage can have a significantly positive environmental impact. For example, a data center located in Espoo, Finland, produces 30 GWh of heat energy to the district heating system, reducing 10 000 tons of CO_2, equivalent to driving a car around the globe 1,650 times. Virtualization means that one device can handle operations of multiple servers. Virtualization can reduce energy consumption by dozens of percentages. Since the data center business is growing, for example Finland is marketing itself as a suitable location for data center investments.

Reasons stated for this are knowledge in energy efficiency and a cool climate that helps in keeping the data center temperature low with less energy use. Already in 2010, the data center business market size in Finland was around 3,000 million euros. (Motiva 2011)

In conclusion, there are major direct environmental impacts of ICT that organizations need to address, in order for them to improve their sustainability performance. Device production and use needs energy and material, and produces greenhouse gas emissions, whereas disposal causes e-waste. Organizations can improve their performance by assessing the environmental performance of the existing ICT infrastructure and implementing policies for reductions. Policies should cover all devices, including data centers, and address all life cycle stages from procurement to use and disposal. There are significant sustainability improvement possibilities through the implementation of best practices. Furthermore, multiple digital solutions enabled by ICT can be beneficial for the environment. As an example, it is estimated that the 12Gt CO_2e avoided through the use of digital solutions is nearly 10 times higher than ICT's expected footprint in 2030 (GeSI 2015). We will look into these solutions in the next sections.

2.3.3 Utilizing Indirect Environmental Effects

The strategic roles of information systems and ICT resources can be classified into three types: informate, automate and transform (Schein 1989). The framework has been widely applied by research to examine impacts of different types of ICT assets and resources on both business performance (e.g. Aral and Weill 2007, Dehning et al. 2003, Weill 1992) and ecological sustainability (Chen et al. 2008, Dao et al. 2011). This framework is used in this research to categorize how digital solutions can improve environmental performance of organizations. In addition, the framework can also be used to analyze how digitalization can help organizations to develop sustainability capabilities, which help improve environmental performance in the long term (Dao et al. 2011).

The strategic roles of digitalization can be defined as follows (adapted from Chen et al. 2008 and Dao et al. 2011):

Automate: Digital solution that substitutes human effort in processes or tasks, reducing or eliminating the hands-on role served by human assets in order to implement them faster, more efficiently and more accurately.

Informate: Digital solution that augments human effort and helps organizations make available timely and relevant data to managers, employees and external entities (e.g., customers and suppliers) so that these individuals better understand the situations faced, in order to carry out processes and tasks more effectively and more efficiently.

Transform: Digital solution that restructures tasks, processes, business assets, capabilities, practices or relationships, in order to help organizations, develop new products, services, or business processes, reposition in the marketplace, or break into new market.

Some digital solutions can combine these different strategic roles, and the line between them can be blurry. A concept such as smart electricity grids can be used as an example of a solution that combines all of the strategic roles of digitalization. Smart grids are characterized with increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid, including dynamic optimization of grid operations and resources and cyber-security (Amin 2011). Smart grids can, for example, automate monitoring, control and reconfiguration in the event of local failures or threats of failure, add much more information about electricity consumption both to producers and end users and can thus create new business models that ultimately transform the way electricity is used and produced (Amin 2011). Despite some digital solutions having more than one strategic role, looking into different strategic roles is one way of analyzing how digitalization is able to improve environmental performance and help to create sustainability capabilities in organizations.

Dao et al. (2011) note that automation can be used in organizations to optimize operations in order to reduce cost and impacts on the environment, for example preventing waste generation. Organizations can automate different business activities by digitizing processes with electronic documents and e-filing systems. This can reduce the costs of organizations' energy use and paperwork processing. Moreover, with technologies such as sensors and RFID, it is possible to automate the collection and processing of multiple environmental indicators, including the use of hazardous substances, emission of pollutants and employee health and safety. Integrating such metrics within key business processes could help organizations improve operational efficiency. In addition, automation can also free employees of mundane tasks. Organizations must then decide whether to cut their payrolls or enable employees to focus on more knowledge intensive process improvement tasks. Thus, in order to develop long-term sustainability capabilities, HR activities such as hiring, training and rewarding must be aligned with the sustainability objectives. (Dao et al. 2011)

Automation can be used in manufacturing processes to gain energy savings and emissions reduction in machinery and equipment production (Shan et al. 2012). Methods used include system optimization, automatic control systems, flow simulation of complex processes, energy monitoring and control systems and implementing integrated automation of industry processes. As an example, an auto-forging cell used in the forging industry can complete the forging process of upsetting, preforging, finish forging, punching, trimming, shaping and so on in a single device. High efficiency and ensuring temperature and technique stability in the forging process improves energy and material efficiency. Another example, from the casing industry, is a digital precision forming machine without pattern casting. It can reduce the time of machining a sand mold and core by applying auto-control technology, which could immensely improve the production efficiency of processing single or small batch casting, again reducing the energy and material needs per output. (Shan et al. 2012)

Automation can also help reduce energy consumption in buildings and city lighting. For example, Siemens implemented a Building Automation and Control System (BACS) in a hospital, which operated on three separate sites (DIGITALEUROPE 2009). Energy savings were acquired through implementation of different advanced control applications on the upgraded building automation system control. These included complete pump and valve intelligence, advanced compressor and ventilation control and a fast boiler plant adaptation algorithm. As another example, the so-called BEopt software automates the process of identifying optimal building designs for zero net energy (Christensen et al. 2006) In addition, CGI's integrated public space management (IBOR) solution helps improve energy efficiency in city lighting (CGIa 2014). IBOR allows for changing lighting automatically based on schedule or sensing of activity. For example, lighting can be reduced in a business district after working hours, lighting can be increased and directed in special events such as concerts, and expressway lighting can be reduced when there are no cars driving. Lights adjust automatically, when cars are present so that safety is not compromised even if unnecessary energy consumption is decreased.

Automation is also useful in waste management. For example, a Finnish company called Enevo (2016) has a vision to transform the financial, environmental and social impact of waste. Enevo's waste analytics solution provides insights that help increase efficiency and transparency in waste management. Most waste containers are collected based upon a static route plan, which means fixed collection points on regular routes. This is inefficient, since fill rates of individual containers vary a lot - some containers can overflow while others are almost empty. Enevo's solution provides sensors that continuously monitor the fill level within the containers and are linked to the waste department's project office via cloud servers. This adds information to the solution that then allows for automation. The automation solution is called Smart Plans dynamic collection route planning system. Fill levels and fill rates are compared to trend data to predict the future waste collection needs. The system analyzes millions of possible collections options and provides the most optimal collection route. This maximizes resource efficiency while minimizing distance travelled and avoiding any container overfill scenarios. The route plan for the next day's collections is downloaded by the truck driver to a tablet PC that is used in the truck to follow the route to the collection sites. Thus, the Enevo solution both automates tasks and informates users. (Enevo 2016)

The strategic roles of informating and automating are combined in a huge variety of digital solutions in industries such as energy and even food services. For example, the Central Energy Management System (CEMS) developed by CGI for households can informate customers through an installed device or mobile application on variable energy prices, weather forecasts and predictions on solar energy production if panels are integrated into the system (CGI 2014b). This kind of information encourages households to energy demand management and renewable energy production. CGI has also developed the Aromi management system for foodservice providers and lunch kitchens. The results of the CGI and Aalto University research show that food waste can be significantly reduced by means of digital tools. The new solutions that reduce the food waste are based on accurate and regular measurement, analytics and more accurate prediction of food consumption quantities (CGI 2017). The solution is important, since 80 million kilos or 15 kilos per capita of food is wasted every year in Finnish restaurants and professional kitchens. Aromi is used in a large number of foodservice providers in Finland (CGI 2017). The Azure Internet of Things solution with low-cost sensors and analytics capability can help reduce energy consumption in buildings, in addition to increasing comfort (Microsoft 2016). The sensors capture input from motion, sound, and temperature in rooms to learn about room occupancy, noise level and heat. Data can be displayed on a central dashboard and shared. Data science helps predict which rooms are never used, and optimize for energy efficiency (Microsoft 2016).

Big data also helps in integrating variable renewable energy sources such as wind and solar to the system. Big data is defined by Manyika et al. (2011) as a term for data sets that are so large or complex that traditional data processing application software is inadequate to deal with them. Big Data is used to predict how much energy will be produced by a source and automatically manage the resources with dynamic optimization of operations. For example, a company called SolarCity in the USA can use data from smart solar panels across 15 states and combine that with additional data, such as weather forecasts, allowing the utility to predict the state of the grid 24 hours in advance, helping to prevent blackouts, brownouts and unnecessary power-source startups and shutdowns. Sensors are also used in wind turbines to collect data on how the wind is hitting the turbine, regulating angles of individual blades to maximize productivity and to predict the power created. Big data solutions are used also in wind turbines to produce three-dimensional models of atmospheric turbulence for thousands of individual turbines, in order to become more efficient and optimize the business model. (HP 2015)

According to Dao et al. (2011), information exchange is key to collaboration among partners in developing a sustainable supply chain, and different digital solutions can help organizations collaborate and develop sustainability capabilities. First, demand for more information about different organizations' environmental impacts are growing from consumers, regulators, investors, and NGOs. Digital solutions together with company policies that encourage and enable openness and transparent information sharing could help companies gain legitimacy regarding sustainability. Additionally, organizations need to develop metrics of sustainability that could be used across the supply chain to measure the environmental impacts of operations at different stages of the chain. Furthermore, solutions such as an enterprise resource planning system or a sustainability performance database can help organizations collect, share and integrate sustainability performance data both within the company and for the whole supply chain. Implementing effective sustainability strategies requires organizations to have a sound understanding of the environmental impacts of the production as well as consumption of their products or services. Integrated and shared information could facilitate organizations in the coordination with suppliers and partners along the supply chain in the development and evaluation of clean technologies and processes. The capabilities to collaborate and share information have been found to be difficult to imitate and thus result in sustained operational excellence and competitive advantage. (Dao et al. 2011)

Information gathered through remote monitoring and diagnostics can reduce environmental impacts in multiple ways. First, remote diagnostics reduces travel related energy and emissions in a range of activities that can be performed without traveling of persons, for example, service engineers calibrating and maintaining advanced instruments at customers' locations from their business home base (Black & van Geenhuizen 2006). Second, remote diagnostics allows condition-based maintenance that can be more material-efficient than regular scheduled maintenance, as components are only replaced on an as-needed basis (Yang et al. 2009). Third, with a remote monitoring service it is possible to provide customers with advice on how to reduce their environmental impacts. For example, by remote monitoring of freezers, it can be shown that the more times the freezer door opens, the more energy is consumed and thus customers can be informed of better practices. (Yang et al. 2009)

Kramers et al. (2014) discuss the role of digital solutions for reduced energy use in cities. They mention many solutions that have informate strategic role. Authors note that the concept of smart city has been used as a strategic concept combining modern urban production factors within a common framework, highlighting the importance and potential of digital solutions in helping the city to develop a competitive advantage. The smart city concept can be further categorized into smart transportation, smart environment, smart healthcare, smart energy, smart education, smart safety and so on.

For example, applications for multimodal travel provide information about different types of public transport and cycling (Kramers et al. 2014). Clear, timely and precise information about transport availability and easy payment systems increase the motivation to use public transport, thus decreasing the energy use and emissions compared to private cars. Furthermore, applications for lift-sharing combined with social media communities increases the capacity of private cars, thus decreasing the energy use per passenger kilometer. In addition, when it comes to household energy use, visualization could affect awareness of energy use and thereby possibly affect energy demand. However, authors note that in order to really reduce energy use, the visualization application needs to be designed so that it captures users' attentions, makes a clear connection between specific actions and effects, and motivates different types of users. Even the environmental impacts of food consumption could be decreased in cities by applications that provide residents with better information on those impacts. Here again, the design of the application should be motivating and easy. (Kramers et al. 2014)

Relating to motivation for sustainability, gamification is a potential tool for organizations to motivate people to act in a more environmentally friendly way (Owen 2013). Gamification refers to increasing user interaction, behavioral change and the stimulation of innovative thinking by means of adding game-like elements into everyday tasks. It is used in sectors as diverse as health and fitness, medical research and the financial sector, and it can also be used in increasing environmental performance in organizations. For example, climate change is often regarded as too disparate, and the potential effects of a warming world are still too distant in both space and time to motivate immediate action by individuals. Thus, there is a need to show people that they are making a difference, maybe not individually, but as part of a team or organization, and here gamification can help. Furthermore, the challenge and competition-based approach of gamification has the potential to motivate a broad spectrum of workers to take part in eco campaigns, since it appeals to the innate, competitive instincts of humans. In conclusion, gamification is a way of giving people the purpose and the challenge they need to get motivated, and regular feedback to informate and encourage on what their impact is and how much progress they are making. (Owen 2013)

According to Dao et al. (2011) and Chen et al. (2008), digital solutions can also help organizations and whole industries completely transform their practices and processes in order to develop radical sustainability. Dao et al. (2011) argue that innovating transformative sustainability solutions requires integrating and bundling of technology with human resources and supply chain management. They note that delivering sustainable value can enable a competitive advantage that is difficult to imitate by the competitors. Furthermore, Chen et al. (2008) say that the introduction of telecommunication, networking and business intelligence can fundamentally alter the nature of the products and the organization's relationship with its customers and suppliers. Authors continue, that digital solutions enable entities to interact more frequently, more easily and more cheaply, and as a result, they can greatly increase the social proximity, interaction frequency and resource dependency among organizations and individuals in a value chain. They conclude that mimetic, normative and coercive institutional pressures all have a role in triggering the transformative role of digital technologies to achieve sustainability.

One digitally enabled transition is the enabling of telecommuting. Remote work is another term that is used in this context. Environmental impacts of telecommuting have been researched quite extensively (Glogger et al. 2003, Kitou & Horvath 2003, Nelson et al. 2007, Perez et al. 2004). Based on these studies, telecommuting can reduce both travel and office building related emissions if policies are aligned correctly, even when the rebound effect is considered. However, there are many variables that need to be investigated further. For example, longer term studies are needed (Perez 2004) and better consideration of both home and office space management of remote workers (Kitou & Horvath 2003). Kitou & Horvath (2003) note that when calculating the environmental impacts of remote work, one should also take into consideration induced travel and latent demand. Induced travel is for leisure, social, and other purposes that would not have occurred without remote work. Latent demand means the additional car kilometers driven due to an increase in available roadway capacity because of telecommuting. All in all, private companies, transportation agencies and metropolitan planning organizations are likely to and should continue to pursue telecommuting to reduce both traffic congestion and air pollution (Nelson et al. 2007, Perez 2004). Kitou & Horvath (2003) argue that in order to gain environmental benefits, the scope and goal of telecommuting programs must be defined early in the implementation process. They conclude, that minimizing the amount of space and equipment used by remote working employees is the key to a successful implementation of remote work programs.

Another large transformation is e-commerce and its effect on mobility patterns, land use regarding malls and warehouses, packaging and, in case of consumer-to-consumer online markets, reuse of products. According to Weltevreden & Rotem-Mindali (2009), e-shopping in the Netherlands seems more efficient than physical shopping, but note that this does not mean that it is always more environmentally friendly than in-store shopping. Authors also found out that consumer-to-consumer e-commerce led to a net increase in the number of trips and distance travelled by consumers. They argue that online markets where consumers can easily buy and sell second hand items is the major cause of this net increase in personal travel. However, authors did not calculate the positive environmental impacts of reuse that consumer-to-consumer markets create. Edwards et al. (2009) also say that on average, the home delivery of e-shopping is likely to generate less CO_2 compared to the typical shopping trip. It was found that, on average, when a customer shops by car and buys fewer than 24 items per trip (or fewer than 7 items in the case of bus users) the home delivery will emit less CO_2 per item purchased. All in all, it seems that just increasing e-commerce in itself does not improve environmental performance, but it has the potential for environmental impact reduction if correct policies are in place. Thus, Fichter (2003) argues that when e-commerce is used for improving environmental performance, an overall view on the value chain is needed, including improved volume utilization of vehicles, avoidance of express delivery by airfreight and minimization of packaging.

In conclusion, there are numerous ways digital solutions can be used in improving environmental performance of organizations. The roles how solutions are used can be divided into automation, information and transformation of process or task. Example of these are presented in table 1. It should be noted, that just using digital solutions can in itself bring environmental benefits, but it is rarely the whole story. In order to make sure that environmental performance is actually improved, there usually needs to be organizational goals and policies that direct the gained efficiencies for the environment and not for other activities.

Table 1. Example of strategic roles of digital solutions.

	Strategic roles		
Digital solutions	**Automate**	**Informate**	**Transform**
Smart grids	x	x	x
Automatic city lighting	x		
Big data for wind and solar	x		
Central Energy Management	x	x	
Aromi food service prediction	x	x	
Building energy management	x	x	
Public transport application		x	
Lift sharing application		x	
Gamification		x	x
Remote diagnostics		x	x
E-commerce			x
Remote work			x

2.3.4 Structural and Behavioral Effects

Structural and behavioral effects of digitalization refer to fundamental changes that the technology can cause on societal scale, such as moving towards a less emission-intensive economy (Berkhout and Hertin 2004). Structural changes enabled by digitalization are already significant, which is captured by the much-cited saying of Tom Goodwin (2015):

> *"Alibaba, the most valuable retailer in the world, has no inventory. Uber, the world largest taxi company owns no vehicles and Airbnb, the world's largest accommodation provider owns no real estate".*

These changes that informate, automate and transform daily activities have the potential to improve environmental sustainability of the whole society, but the results are to be seen. Analyzing structural and behavioral effects need both broader perspective and longer timespan. For example, when studying mobility effects of e-commerce, overall view can change if longer term behavioral changes are researched compared to individual trips. Hiselius et al. (2015) note that the majority of online shoppers are younger, and as this generation grows older they will bring these habits with them. They continue that frequent online shoppers are more likely not to have a driver's license. If e-commerce and other digital solutions can improve life without car and as such reduce car buying altogether, impacts will be far greater than just individual travel comparison. More actions on the less emissions intensive economy are needed, since according to PWC (2017) carbon intensity – emissions per dollar of GDP – needs to be reduced 6.3 % per year to limit global warming to well below two degrees - the main objective of the Paris Agreement. In 2016 carbon intensity fell only by 2.6% PWC (2017).

Virtual consumption is an example of trend that could reduce environmental impacts compared to material consumption (Lehdonvirta 2009). Virtual consumption serves many of the same kind of purposes as material consumption, and indeed is a substitute for material consumption in many social worlds that frequently gather online. Even though virtual consumption is no free of environmental impacts, they are in most cases far smaller compared to their material counterparts. Firstly, virtual consumption to a large extent uses the same devices and network infrastructure already in other use, so it only partially represents an additional environmental burden. Secondly, the environmental impact of virtual consumption does not increase as a function of the number of goods purchased. This is a key difference to material consumption, where each additional unit purchased represents a direct increase in environmental footprint. Thirdly, the disposal of virtual goods does not produce waste that needs to be managed or recycled. It is even possible for to create short-lived disposable virtual goods that keep databases lean without increasing the environmental burden in any way. Fourthly, in contrast to traditional goods and services, virtual goods do not involve physical transportation, either of the good to the consumer or of the consumer to the site of service delivery. Thus, substituting a certain amount of material consumption with virtual consumption could conceivably improve environmental sustainability. (Lehdonvirta 2009)

The development of sensors and analytics has led to innovation in mobility through autonomous vehicles and drones. Here again the impact on the environment could be positive or negative depending on technological and policy choices that have yet to be made (Worland 2016). According to Brown et al. (2013) the estimates of possible impacts of autonomous vehicles compared to current ones range from nearly 90% fuel savings to more than 250% increase in energy use. The most energy efficient scenario could be even better, since authors did not account for possibility of fewer vehicles in shared use model and land use benefits of repurposing of parking. It is estimated that only 12% of vehicles are on the road even at the peak, so sharing self-driving cars could lead to a major environmental benefit (Brown et al. 2013). Realizing environmental benefits requires conscious choices from auto manufacturers and policymakers to prioritize efficiency. For example, cars could be programed to choose the most fuel-efficient route and rules should penalize cars driving unoccupied and reward those who allow their vehicles to be used for ride-sharing (Worland 2016).

Drones are another technology that could be used for improving environmental sustainability - for example to plant trees at industrial scale (Edmond 2017). It is estimated that currently about 15 billion trees a year are being chopped down and only about 9 billion are being planted and thus there is a net loss of 6 billion trees a year. BioCarbon Engineering, a UK-based company backed by drone manufacturer Parrot, has come up with a method of planting trees quickly and cheaply even in areas that are difficult to access or otherwise unviable. The drones work by scanning the topography to create a 3D map. Then the most efficient planting pattern for that area is calculated using algorithms. A drone loaded with germinated seeds fires pods into the ground at a rate of one per second, or about 100,000 a day. Scaling this up means that 60 drone teams could plant 1 billion trees a year. The company engineers estimate that their method is about 10 times faster and only 20% of the cost compared to hand planting. The BioCarbon team has tested drone technology in various locations and similar idea is being used other companies such as Oregon start-up DroneSeed. DroneSeed is attempting to create a new era of "precision forestry" with the use of drones to plant trees as well as spray fertilizer and herbicides. (Edmond 2017)

Linturi (2016) lists robotic transportation, urban farming, sharing economy and Internet of Things as future digital enabled socio-technical innovations that have high impact on either resource efficiency or sustainable development. Robotic transportation can be seen as larger structural change than just self-driving cars and drones. The key is in integrated transport service that includes public transport and robotic taxis enabling more freedom compared to privately owned cars. Cargo transport and home delivery would also benefit from self-driving cars and drones enabling far more efficiency compared to current logistics systems. Environmental benefits would include reduced number of cars, parking spaces, roads and thus more compact urban structure reducing the growth of cities. Parking garages can be used for LED-light based urban farming, where sensors and analytics control closed ecosystem with precise amount of nutrients and light thus reducing negative environmental impacts of regular farming. Digitalization also enables sharing economy which increases the utilization rate of properties and products thus decreasing the private ownership and environmental impact related to that. The key efficiency in digital enabled sharing economy is in the global identification mechanisms improving trust and reduced transaction costs. Finally, internet of things could improve our real time understanding of the environment we are living and environmental impacts of we are producing. (Linturi 2016)

The issue that has to be covered when considering the ability of digitalization's structural effects to reduce the energy and emission intensity of the whole society is called the rebound effect (Berkhout and Hertin 2004). The rebound effect mean that behavioral changes usually offset some of the gains in efficiency. As digitalization improves the management of time and reduces amount of money used labor needed, it also creates new demand (Berkhout and Hertin 2004). Antal & van den Bergh (2014) have studied rebound mechanism in re-spending of money savings associated with energy savings on energy intensive goods or services. Authors find that emerging economies typically have larger rebounds than OECD countries and since such economies play an increasingly important role in the global economy the re-spending rebound is a growing concern. They continue that the re-spending effect is generally larger for gasoline than for natural gas and electricity and that, paradoxically, stronger financial incentives to conserve energy tend to increase the rebound. Freire-González (2010) estimated the magnitude of direct rebound effect for energy services using electricity in households of Catalonia. The results showed an estimated direct rebound effect of 35% in the short term and 49% in the long term. Whether this new demand from digitalization will offset de-materialization effects stimulated by it, depends largely on the collective choices of consumers and policies of the regulators (Berkhout and Hertin 2004).

Analyzing the total effects of digitalization for society is not easy, but the #Smarter2030 report estimates that greenhouse gas emissions avoided through the use of ICT solutions can be nearly 12 Gigatons of CO2-equivalents or 10 times higher than ICT's expected footprint in 2030 (GeSI 2015). The avoided emissions are divided gained from mobility, manufacturing, agriculture, buildings and energy sectors. Mobility solutions consider ICT-enabled improvements to private and commercial mobility and additionally consider the reduced need to travel from various sectors, including health, learning and commerce. In other sectors ICT enables emission reductions through automation systems, monitoring and forecasting systems and smart production system. ICT also offers environmental benefits beyond carbon mitigation, helping to reduce the consumption of scarce resources and increasing resource efficiency. The report claims that in agriculture, crop yields could increase by 900kg per hectare; in energy, 25 billion barrels of oil could be saved across all the sectors and in transport 135 million cars could be taken off roads. They also argue that ICT could save over 300 trillion liters of water, across the eight sectors as a whole. (GeSI 2015).

3. METHODOLOGY

3.1 Research design

The goal of the empirical study is to support answering the research objective. The objective of this study is to understand how different organizations view digitalization in improving environmental sustainability. Together with CGI, we decided that the empirical study would focus on organizations that operate in Finland, in order to make the scope more manageable for the thesis.

Silverman (2005) says that the choice of methodology in a scientific study should primarily reflect to what knowledge is wanted to be gathered, but also taking into account the available resources and personal preferences of the researcher. As the objective this thesis is to understand the overall views of organizations operating in Finland, a web survey and its quantitative and qualitative analysis was chosen as the research method. Furthermore, there is a research gap in surveys relating to the use of digital technologies in environmental sustainability improvements in Finland, so conducting a survey is a relevant way to gather new scientific information.

3.2 Data Collection Methods

The questions for the survey were chosen based on the research objective, the research questions and on CGI needs. The full questionnaire in Finnish can be found in Appendix A, and the overall questionnaire structure is explained also in the following.

The survey began with an introduction explaining that the survey is for a Master’s thesis research in Aalto University and that it is supported by CGI. The topic of the survey was presented to be about how digitalization and sustainable development are connected in Finnish companies and public sector organizations. In addition, we encouraged respondents to spread the survey within their own organization, since we wanted to have responses from people with varying positions. It was told that response time would be around 10 to 15 minutes. Results were to be confidential and anonymous, and there would be no possibility to point out a single organization from the answers. Digitalization and environmental sustainability were defined, and respondents were motivated to answer by promising the conclusion report for them to see at the time of publication.

The survey was structured so that the first questions were about the respondent's organization type and the respondent's position in the organization. These were followed by three claims concerning the importance of digitalization, with which the respondent could agree or disagree. The survey continued with questions about public goals relating to environmental sustainability, and whether the organization had a Green IT strategy, and if so, what the respondent's opinion on it was.

The next part of the survey was categorized according to types of environmental effects presented by Berkhout and Hertin (2004). First, there were questions on actions and views regarding IT's direct impacts, then indirect impacts and finally structural and behavioral impacts. On all of these categories, there were question on what environmental impacts the company has focused on or is interested in focusing on in the future. Here we chose to divide environmental impacts into energy use, emissions, material and waste. According to the CGI sustainability practice, these are usually the most common environmental impacts focused on in Finnish organizations. In addition, there were questions concerning each category specifically, such as the focus on devices in the direct impact part, and how certain ways digitalization was used to reduce organizational environmental impacts in the indirect impact part.

Final parts of the questionnaire concerned motivation for environmental impact reduction in organizations, whether the organization had public reporting about environmental sustainability and finally the same three claims on digitalization's importance that were in the beginning of the survey. This was because we wanted to know if answering the survey would affect the respondents' views. Also, if respondents answered that they had public reporting, they had more questions regarding the type and content of those reports. At the end of the survey, there were questions about interest to receive the conclusion report or a visit from CGI experts, in addition to contact information if the answer was positive to either of the last two questions.

Most questions were multiple-choice questions with either a single answer, where options were exclusive (e.g. Does your organization have a Green IT strategy - choices yes, no and I don't know) or multiple-answer options (e.g. To what devices has your organization focused on when reducing the direct environmental impact of IT - choices servers, phones, workstations, printers, network devices and other, please specify). In addition, there were some open questions where respondents could further elaborate on the actions their organization had taken and their views.

3.3 Data Collection Process

Answers to the web survey were gathered between the 8th of April and the 10th of June in 2016. A total of 249 answers were received. The survey was open in CGI Finland company web page, email about the survey was sent to CGI customers, the survey was spread also in social media and some partner organizations also spread the survey in their network.

Social media channels included Twitter and LinkedIn posts with pictures to draw attention. We motivated potential respondents to answer the survey by including the possibility to receive the conclusion report on the survey results. No other motivation for respondents' efforts, such as gift cards or lotteries, was used. The conclusion report was published in Finnish as a white paper called Digitalisaatio kestävän kehityksen vauhdittajana - tutkimus suomalaisista organisaatioista (Digitalization as a driver of sustainable development – a research study on Finnish organizations) and it was sent to interested respondents on the 21st of February 2017.

Based on our data, it seems that from all the different survey spreading methods the most important method was emails sent to CGI Finland customers whose addresses were collected from the CGI database. The email was sent to a total of 6,923 email addresses. Email was sent to the same people who receive the CGI Finland magazine called Ratkaisu (Solution in English), except that we also limited the respondents to organizations that have over 500 people in them, according to the customer database.

Quite a large number of these addresses were not active and did not open the original email or neither of the two remainders. A total of 2,280 people opened any of the emails, so it seems that quite many of the emails in the database were not active addresses. 391 people opened the survey, which means that the survey's opening rate was 17 %.

There is no way to know for certain how many answers were given based on the sent email, from social media or from the CGI Finland front web page, but analysis from the answer dates tells us something. The three biggest answer spikes in the daily answer amount were exactly on the dates when the first email about the survey and the reminders were sent. The amount of answers from email sending days totaled 172, which is over 69 % percent of all the answers. In addition, 166 respondents answered that their organization has over 500 employees. However, the exact number about the answer sources cannot be given. Some answers on the email sending days probably came from other sources too. On the other hand, many answers based on email were probably given a few days after the email was sent. All in all, it seems that most of the answers were given based on the emails.

3.4 Data description

A total of 249 answers to the survey were received. A breakdown of different respondent positions and organizational characteristics are presented in the following.

Organizational employer sectors are presented in figure 5. Nearly 45 % (n = 111) of respondents worked in private sector companies and 50 % (n = 125) in the public sector, either in government or in municipalities. The rest responded working for other sectors, such as foundations, NGOs, or institutions or companies owned by the government.

Figure 5. Employer sector of respondent organizations

Industrial classification according to the respondent organizations is presented in figure 6. Categorization is done according to standard industrial classification (Tilastokeskus 2008). Those categories that had fewer than 10 responses were combined under the category "other". Since 50 % of respondents work in the public sector, it is no surprise that public administration and defense was the largest category with 94 respondents working in that field.

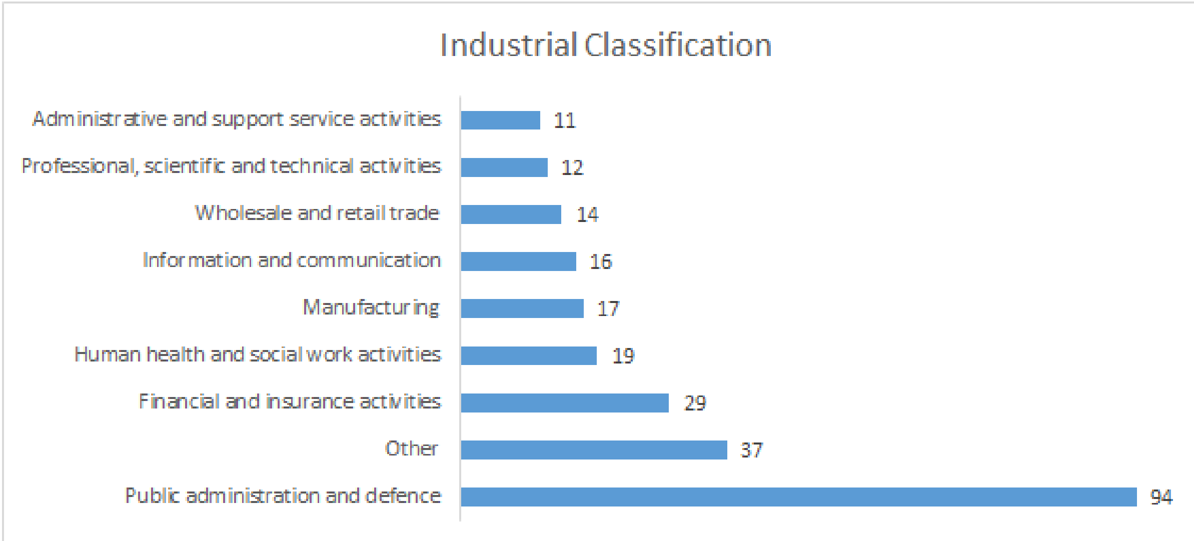
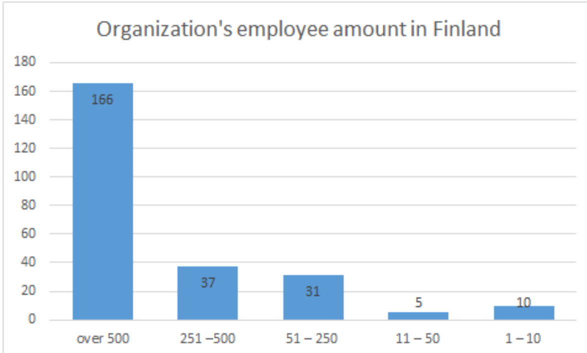


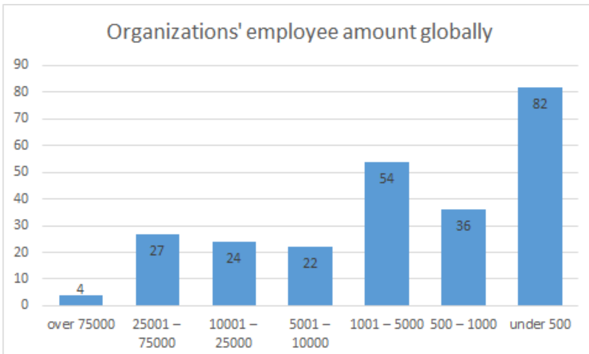
Figure 6. Industrial classification of respondent organizations

The study concerned organizations working in Finland. The survey was published in Finnish in Finland, but organizations working in Finland could have activities elsewhere as well. Still, most of the responses, total of 196, came from Finnish organizations. There were 23 responses from organizations that have headquarters in Finland, but have international activities as well. Only 30 responses came from international organizations that have headquarters elsewhere, but work also in Finland. Organizations' internationality is presented in figure 7.

Figure 7. Internationality of respondent organizations

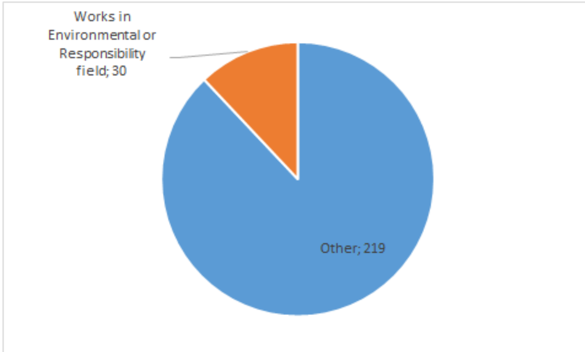
The study focused on medium size and large organizations, since they are assumed to have more interest in environmental sustainability and digitalization due to more resources, higher regulation, and higher customer pressure (Stanwick & Stanwick 1998, Baylis et al. 1998, Collins et al 2007, Bose & Luo 2011, Hörisch et al 2015). The survey was sent especially to customer organizations with over 500 employees according to database. In figures 8a and 8b are presented the respondent organizations' employee amounts in Finland and globally. Most organizations had over 500 employees and over 80 % (n = 203) have over 250. When looking at global employee amounts, one third had under 500 (n = 82) employees and nearly two thirds fell between 500 and 75 000 employees (n = 163).





Figures 8a and 8b. The employee amounts of respondent organizations in Finland and globally

We also asked about the respondent's position in their organization. We were interested in knowing if the answers differed due to the respondent being in a leadership position or an expert. Most respondents answered directly within the given categories, but 48 respondents specified other positions. However, even of those, it was easy to categorize respondents as belonging to either expert or managerial positions. In addition, we wanted to know if the answers differed due to the respondent's field of work relating to responsibility and the environment or not. Figures 9a and 9b present these differences. We had nearly a 50-50 division between experts and people in a leadership position. Most of the respondents did not work in a field relating to environment or responsibility (n = 219) and only 12 % (n =30) did.



Figures 9a and 9b. Respondent position breakdown. Number of respondents working in environmental and responsibility field compared to all others. Number of experts compared managers and leaders.

3.5 Data Analysis Methods

The data was analyzed both with Excel and with statistical analysis language R. Results of the overall answers to the survey were plotted as figures in Excel. Statistical analysis was used to find out differences within total of five independent variables of which three concerned organizational factors and two respondent positions. Organizational factor variables chosen were employer sector, industrial classification and internationality. It was also looked into two respondent position variables: first experts were compared to managers and leaders and second people working in environmental and responsibility fields were compared to all others. The distribution of responses within values of each independent variables were presented in chapter 3.4 Data description.

Within all independent variables, differences were compared to a chosen reference value. In employer sector, reference value was chosen to be private sector to which government and municipalities were compared. In industrial classification the reference value was chosen to be public administration and defense to which all other industries were compared. In internationality, reference value was chosen to be Finnish organization to which two types of international organizations, depending on their headquarters, were compared. Regarding respondent positions, people working in environmental or sustainability fields were compared to all others and leaders and managers were compared to experts.

Most questions in the survey were binary in nature. Odds ratios are provided to those analyzes that had p-value of 0.05 or less. The concept of odds ratio is explained in the following. For these binary questions so called generalized linear model was used as the analysis method. In binary questions the model calculates probabilities for a given answer and produces an odds ratio between reference value and another value of independent variable. For example, we can look into a question of whether the respondent organization had taken actions in reducing direct impacts of work stations. One of the results was that the information and communication industry was only 0.14 times as likely to have taken action on workstations ($p = 0.007$) compared to public administration and defense. First the probability of having actions on workstations in information and communication industry was 40 %. Thus, probability of not yet taking actions was 60 %. Odds for actions taken regarding work stations in that industry is 40 % divided by 60 %, which is 0.67. Similar probabilities for public administration and defense were 83 % for actions taken and 17 % for not. Odds for action are thus 4.88. Odds ratio is division between these: 0.67 divided by 4.88 equals 0.14, which means that the information and communication industry was only 0.14 times as likely to have taken action on workstations compared to public administration and defense (UCLA 2017).

In questions regarding motivation for environmental sustainability and perception on digitalization and sustainability, the answers were given in Likert scale. In motivation questions answer scale was from 1 to 5, where 5 represents a high motivational factor and 1 represents a low motivational factor. Regarding perception, respondents were questioned to what extent they agree or disagree with a given statement on a scale reflecting the numbers 1 to 5 as: 1 strongly disagree, 2 disagree, 3 neutral, 4 agree, 5 strongly agree. Analyzes for these questions were done using linear model comparing the mean of the reference value to all other values of the independent variables. Comparison of means are provided for to those analyzes that had p-value of 0.05 or less. Although calculating means for Likert scale cannot be regarded as good scientific practice, it is usually helpful in making decisions in user research (Sauro 2016). Even if attitudes and perceptions cannot be measured with the precision of pure scientific variables, it is generally accepted in the social sciences that self-reported data can be regarded as continuous (interval) and used in parametric statistics (Blunch 2008, p. 83).

4. RESULTS

4.1 Motivation for Environmental Sustainability

Results for motivating factors related to the reduction of organizational, or larger supply chain, environmental impacts are presented in figure 10. The response scale was from 1 to 5, where 5 represents a high motivational factor and 1 represents a low motivational factor. The motivating factors are sorted by the highest motivating factor from top to bottom by the average of each factor. Respondents could also choose "I don't know" or not answer at all for each given motivational factor, and such answers were not considered in averages.

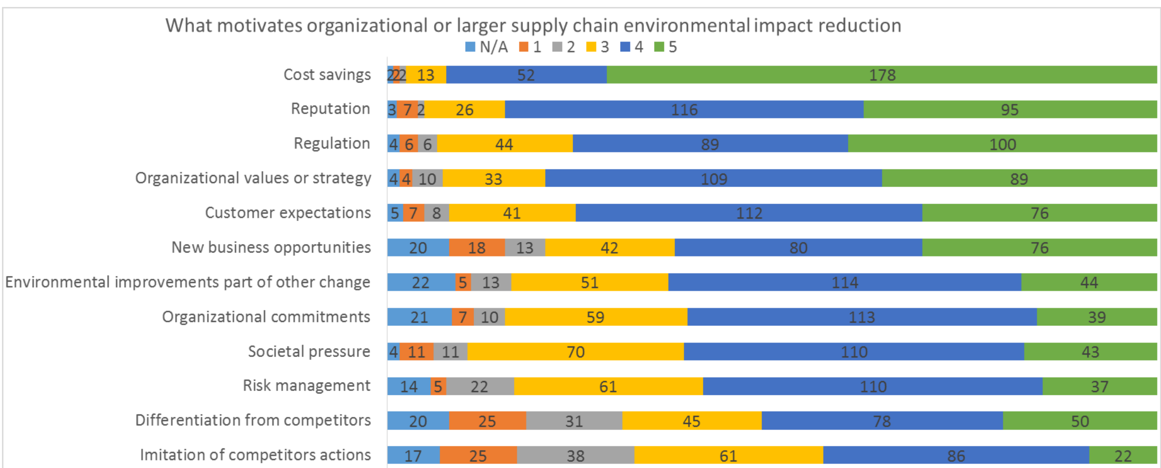


Figure 10. What motivates organizational or larger supply chain environmental impact reduction. 5 represents high motivational factor and 1 represents low motivational factor.

From the responses, we can clearly see that cost savings was the most important factor motivating environmental impact reductions in organizations. High motivational factors included also reputation, regulation and organizational values or strategy. In the overall results, imitation of competitor actions and differentiation from competitors were the least motivating factors.

There were some statistically significant differences in motivation depending on organizational characteristics and respondent position that are presented in table 2A.

Data regarding organizational factors and respondent positions were presented in chapter 3.4 Data Description and methodology in chapter 3.5 Data Analysis Methods. Since there were so many findings on motivational differences depending on industrial classifications, they are presented later in table 2B. In table 2A you can note, that private sector organizations were significantly more motivated by competitors, business and customers, compared to the public sector. In addition, international organizations that have headquarters outside of Finland reported being more strongly motivated by a total of eight different factors compared to Finnish organizations. Also, international organizations with headquarters in Finland reported higher motivation by imitation of competitor actions, differentiation from competitors and customer expectations. Finally, respondents working in environmental or responsibility roles were more motivated by risk management compared to all other roles.

Table 2A. Differences regarding motivation for organizational or larger supply chain environmental impact reduction, depending on organizational characteristics and respondent position. Averages are compared to the reference value noted on the top row. For example, municipalities have on average a motivation value by imitation of competitor actions of 2.86 compared to 3.57 in the private sector.

	Employer sector: below sectors are compared to private sector		Respondent position: Environmental or responsibility roles are compared to other roles	Organization's internationality: below values are compared to Finnish organizations	
Motivational factors	**Municipality**	**Government**		**International organization, headquarters not in Finland**	**International organization, headquarters in Finland**
Imitation of competitor actions	2.86/3.57 (p = 0.00008)	2.67/3.57 (p = 0.000003)		3.87/3.04 (p = 0.001)	3.50/3.04 (p = 0.046)
Differentiation from competitors	3.04/4.01 (p = 0.000002)	2.57/4.01 (p = 0.00000000001)		4.17/3.21 (p = 0.0004)	4.14/3.21 (p = 0.0002)
New business opportunities	3.33/4.12 (p = 0.00003)	3.52/4.12 (p = 0.001)		4.65/3.65 (p = 0.0001)	
Customer expectations	3.76/4.23 (p = 0.001)	3.76/4.23 (p = 0.002)		4.39/3.88 (p = 0.012)	4.41/3.88 (p = 0.004)
Reputation	3.95/4.30 (p = 0.001)			4.52/4.12 (p = 0.037)	
Risk management			4.00/3.60 (p = 0.025)	4.05/3.61 (p = 0.038)	
Organizational values or strategy				4.55/4.05 (p = 0.012)	
Organizational commitments				4.09/3.68 (p = 0.046)	

Table 2B presents differences in motivation for organizational or larger supply chain environmental impact reduction depending on industrial classification. The comparison was made to public administration and defense, and results show that almost all other industries had higher motivation by imitation of competitor actions, differentiation from competitors, new business opportunities and customer expectations. Furthermore, cost savings motivated both human health and social work activities and wholesale and retail trade industries more than they motivated public administration and defense.

Table 2B. Differences regarding motivation for organizational or larger supply chain environmental impact reduction depending on industrial classification. Industrial classifications are in left column. Motivational factors and values for values for public administration and defense are in the second most top row.

	Motivational factors: left column industries are compared to industry: public administration and defense.				
Industrial classifications	**Imitation of competitors actions - 2.65**	**Differentiation from competitors - 2.75**	**New business opportunities - 3.27**	**Customer expectations - 3.75**	**Cost savings - 4.61**
Professional, scientific and technical activities	3.36 (p = 0.011)	4.00 (p = 0.0009)	4.42 (p = 0.001)	4.50 (p = 0.008)	
Administrative and support service activities	3.55 (p = 0.0006)	3.55 (p = 0.032)	4.18 (p = 0.013)		
Information and communication	3.69 (p = 0.035)	3.81 (p = 0.0009)	4.25 (p = 0.002)	4.25 (p = 0.043)	
Financial and insurance activities	3.69 (p = 0.00001)	4.11 (p = 0.0000002)	4.03 (p = 0.002)	4.31(p =0.004)	
Manufacturing	3.56 (p = 0.002)	4.19 (p = 0.000009)	4.20 (p = 0.004)		
Human health and social work activities	3.32 (p = 0.017)	3.33 (p = 0.053)	4.12 (p = 0.006)		4.95 (p = 0.050)
Wholesale and retail trade	3.71 (p = 0.0008)	4.29 (p = 0.000007)	4.23 (p = 0.005)	4.36 (p = 0.021)	5.00 (p = 0.047)

4.2 Perceptions on Digitalization and Sustainability

The survey asked the respondents about their perceptions on the connection between digitalization and sustainability. The respondents were asked to rate the connection between digitalization and sustainability in general and in their own organization, both currently and in the future. Figure 11 presents results on these questions. It is interesting to note, that 90 % of respondents (n = 225) agreed somewhat or completely with the claim that digitalization and sustainability are highly connected.

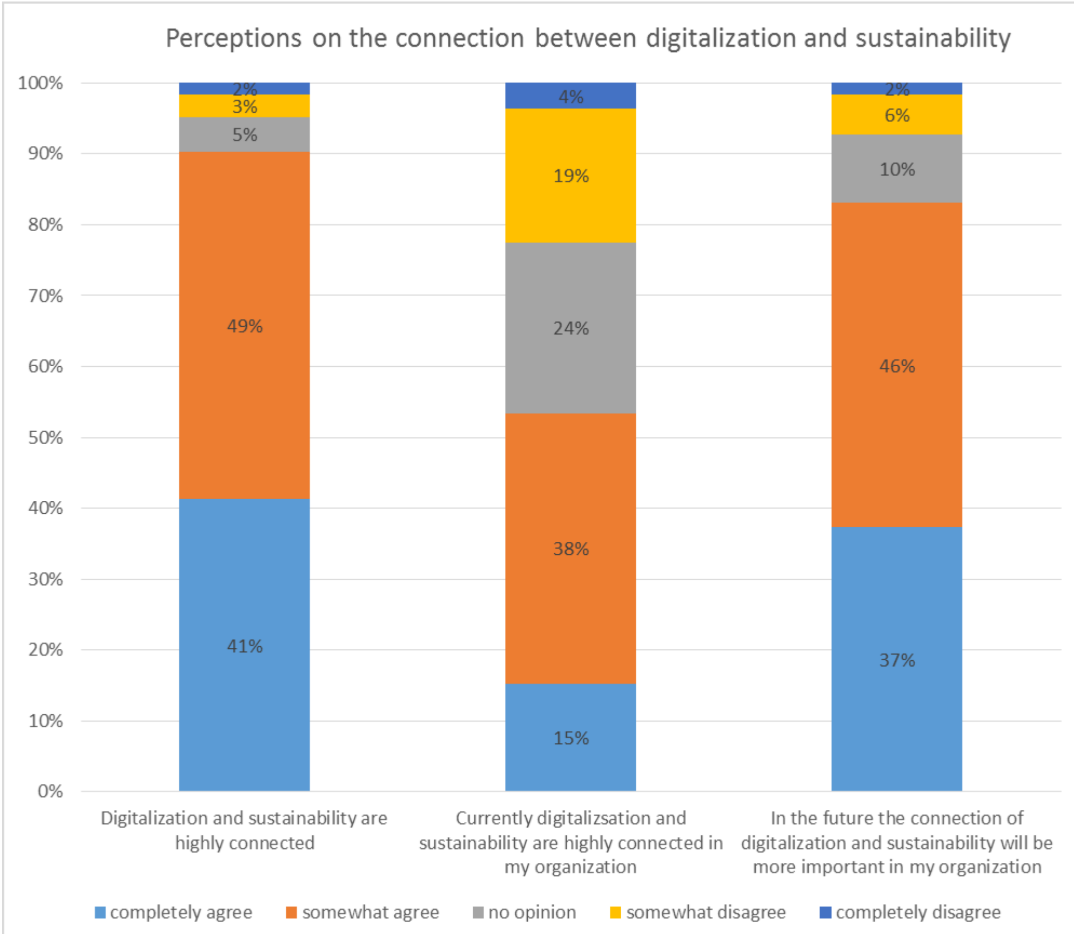


Figure 11. Respondent opinions on the connection between digitalization and sustainability

Respondents were more critical when asked about the connection of digitalization and sustainability in their organization currently. Only 53 % (n = 133) agreed with that statement, a total of 23 % of respondents (n = 56) disagreed somewhat or completely, and 24 % (n = 60) had no opinion. Clearly there is still lot to be done in many organizations regarding digitalization's role in improving environmental sustainability.

When looking at the future of respondent organizations, the results were again very supportive of the importance of a connection between digitalization and sustainability. A total of 83 % of respondents (n = 207) believed that in the future the connection of digitalization and sustainability would be more important in their organization. It seems that, in general, there is more interest for sustainability through digitalization in the future compared to actions taken already. This observation is strengthened by several other answers later on in the results.

Results were very similar regardless of organizational factors or respondent position. The only statistically significant difference found was that international organizations with headquarter outside of Finland seem to agree more that digitalization and sustainability are connected compared to Finnish organizations. When opinions ranging from "completely agree" to "completely disagree" were put on a scale from 5 to 1, international organizations had an average 4.57 and Finnish organizations 4.20 ($p = 0.042$)

4.3 Reducing Direct Environmental Impact of IT

Regarding the direct environmental impacts of IT, the survey asked what actions the respondent organizations had already taken, and what their interests were for the future. Responses were requested about different IT equipment, stages of life cycle and the types of environmental impact focused on in the organizations. Overall, 53 % ($n = 132$) of the respondent organizations had already taken action to reduce direct environmental impacts. An interest in reducing environmental impacts of different IT equipment was mentioned in a total of 70 % of responses. Around 5 % responded as having no interest for any IT equipment environmental sustainability, and 25 % did not know. Quite similarly, regarding environmental aspects, around 86 % of respondents showed interest in at least one aspect, 4 % responded no interest, and 10 % did not know.

Figure 12 presents different IT equipment, and the extent to which respondent organizations had taken actions, or had interest to take actions in the future, when reducing the direct environmental impact of IT. There was more interest in the future concerning all of the mentioned IT equipment compared to actions taken already. In both actions taken and interest in the future, the different equipment were mentioned from the most to last in the same order: work stations, printers, servers, cellphones and network equipment. Workstations and printers had highest interest in the future with values of 57 % (n = 142) and 54 % (n = 135) respectively, and regarding both equipment 40 % of respondents (n = 99) reported that their organization had already taken action to reduce the environmental impacts. There were much less actions taken and interest in the future regarding servers, cell phones and network equipment. The result is interesting, since in many organizations, servers take up quite a large share of the total electricity consumption of IT equipment (Van Heddeghem et al. 2014).

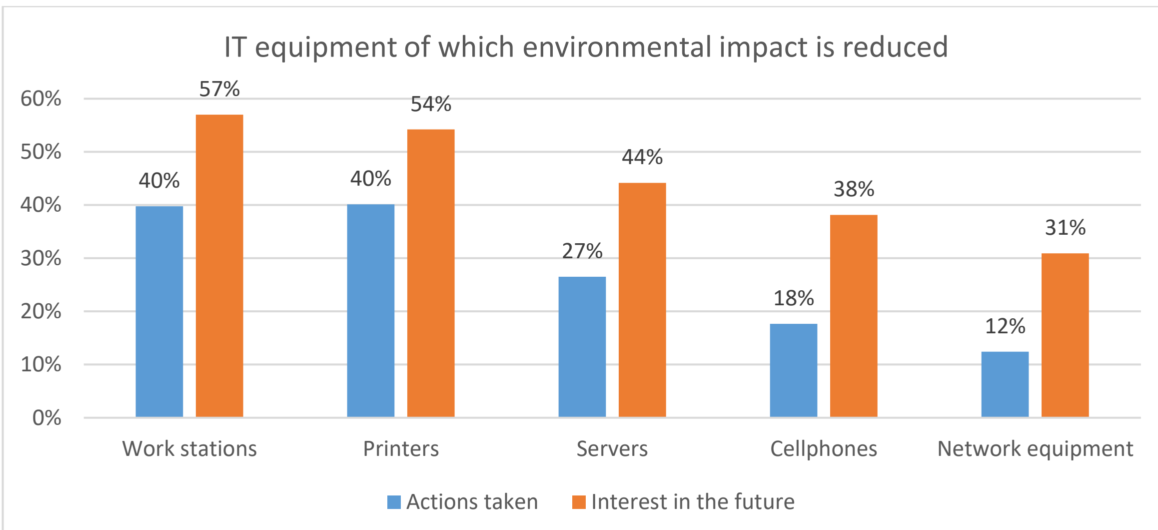


Figure 12. Actions taken and interest in the future on different IT equipment.

There are some interesting results regarding the differences between organizational characteristics and respondent positions that are presented in table 3. Odds ratios were explained in chapter 3.5 Data Analysis Methods. The information and communication industry had quite a lot of differences compared to public administration and defense. In general, it was far more likely in that industry to have both actions taken and interest in the future regarding servers and network equipment, compared to public administration and defense. Also, human health and social work activities were more likely to have actions taken and interest in the future regarding network equipment. However, the information and communication industry was only

0.14 times as likely to have taken action on workstations (p = 0.007) compared to public administration and defense. Regarding printers, the industries of manufacturing, administrative and support service activities and professional, scientific and technical activities all had either less actions taken or less interest in the future, compared to public administration and defense. Moreover, municipalities were more interested in the future about both printers and workstations compared to the private sector. Furthermore, international organizations were only 0.27 times as likely to have taken action regarding printers compared to Finnish organizations. There were no statistically significant differences regarding respondent position.

Table 3. Differences regarding IT equipment depending on organizational characteristics. Top rows present the independent variables and left columns the explanatory variables. The first number describes the odds ratio and the number in parenthesis is the p-value.

		Industrial classifications: below industries are compared to public administration and defence					Organization's internationality: International organization, headquarters not in Finland is compared to Finnish organization	Employer sector: Municipality is compared to private sector
		Information and communication	Human health and social work activities	Manufacturing	Professional, scientific and technical activities	Administrative and support service activities		
Work stations	Actions taken	0.14 (p = 0.007)						
	Interest in the future							2.08 (p = 0.025)
Printers	Actions taken			0.15 (p = 0.027)		0.14 (p = 0.043)	0.27 (p = 0.025)	
	Interest in the future				0.24 (p = 0.039)			1.88 (p = 0.050)
Servers	Actions taken	9.35 (p = 0.040)						
	Interest in the future	3.41 (p = 0.046)						
Cellphones	Actions taken							
	Interest in the future							
Network equipment	Actions taken	6.45 (p = 0.011)	5.16 (p = 0.019)					
	Interest in the future	4.13 (p = 0.012)	5.38 (p = 0.002)					

Figure 13 presents the life cycle stages of IT equipment that organizations have focused on and are interested in the future. Here again, interest in the future was higher for all stages than actions currently taken, and the order of most mentioned stages stayed the same in both actions taken and future interests. Disposal of IT equipment received most attention with 43% of the respondents (n = 106) answering actions taken. 38 % of respondents (n = 94) reported actions taken on use and only 33 % (n = 82) on purchase of IT equipment.

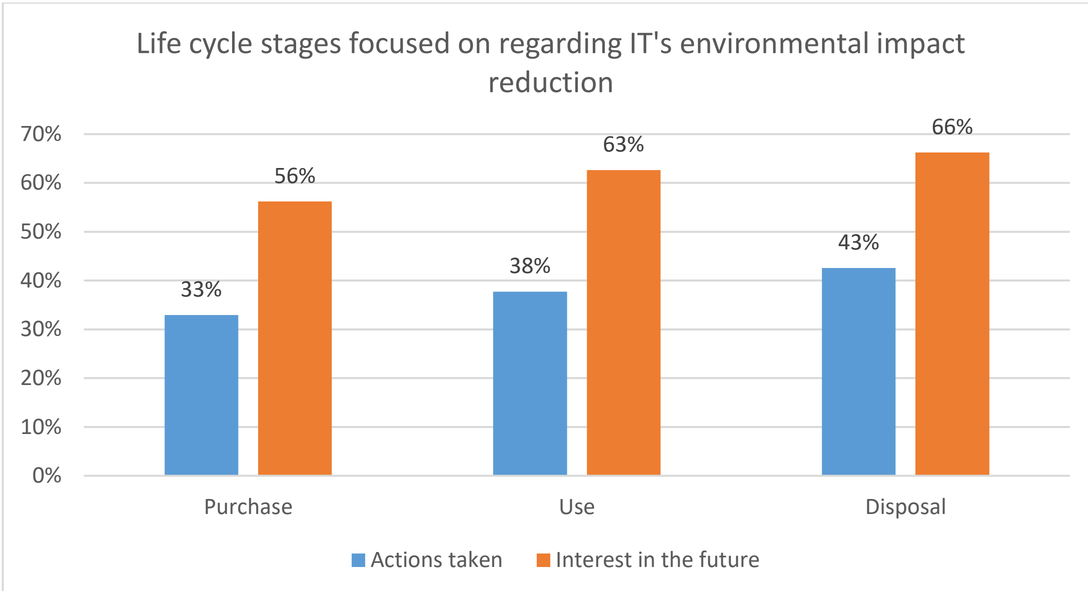


Figure 13. Life cycle stages focused on regarding IT’s environmental impact reduction

Regarding life cycle stages, there was a very limited amount of statistically significant differences within the responses depending on organizational characteristics or respondent position. The only differences concerned future interests depending on industrial classifications and employer sector. In human health and social work activities it was 4.82 times as likely to have interest in the future regarding disposal ($p = 0.043$) compared to public administration and defense. Moreover, in financial and insurance activities it was only 0.40 times as likely to have interest in the future regarding purchase ($p = 0.034$) compared to public administration and defense. Furthermore, it was 2.01 times as likely have interest in the future on purchase in municipalities ($p = 0.033$) compared to private sector. No other statistically significant differences were found.

Figure 14 presents the environmental aspects respondent organizations have focused on in reducing the direct impacts of IT equipment. As noted already in the life cycle stage results, waste received most attention from the respondent organizations with the value of 43 % (n = 106). A total of 40 % of respondents (n = 98) reported that their organization has reduced IT's energy use, 27 % (n = 66) reported actions on material use and only 14 % (n = 35) have focused on emissions of IT equipment. Interest in the future was again higher in all categories compared to actions taken. Waste and energy received the most interest in the future followed by material use and emissions.

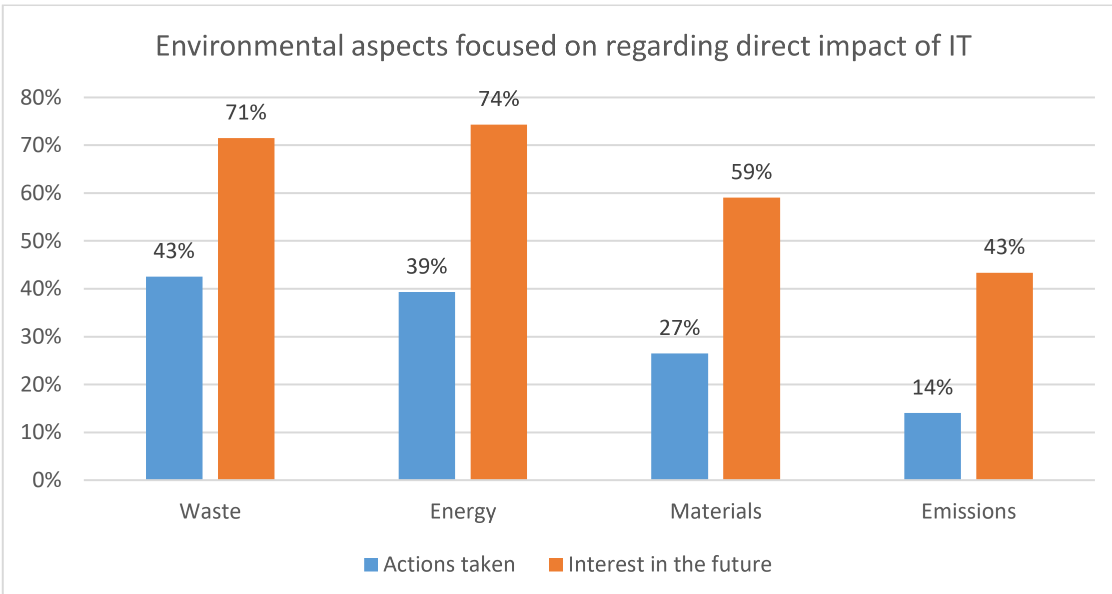


Figure 14. Environmental aspects focused on regarding the direct impact of IT

Differences regarding direct impact environmental aspects depending on organizational characteristics or respondent position are presented in table 4. There was no sustained focus of both actions taken and interest in the future for any organizational characteristic regarding any environmental aspect. In contrast, only isolated differences could be found. Managers mentioned actions taken regarding materials twice as much as experts. Municipalities were twice as interested in waste in the future compared to the private sector. The largest difference in results regarding industrial classifications, were that in the information and communication industry it was 12.31 times as likely to have actions taken on emissions ($p = 0.003$) compared to public administration and defense.

Table 4. Differences regarding direct impact environmental aspects depending on organizational characteristics and respondent position. Top rows present the independent variables and left columns the explanatory variables. The first number describes the odds ratio and the number in parenthesis is the p-value.

		Industrial classifications: below industries are compared to public administration and defence			Employer sector: municipality is compared to private sector	Respondent position: Managers and leaders are compared to experts
		Information and communication	Professional, scientific and technical activities	Financial and insurance activities		
Waste	Actions taken					
	Interest in the future				2.17 (p = 0.041)	
Enery	Actions taken					
	Interest in the future		0.25 (p = 0.030)			
Materials	Actions taken					2.09 (p = 0.037)
	Interest in the future			0.39 (p = 0.034)		
Emissions	Actions taken	12.31 (p = 0.003)				
	Interest in the future			0.31 (p = 0.020)		

4.4 Improving sustainability through Indirect and Structural effects of Digitalization

This chapter concerns both the indirect and the structural and behavioral effects that digitalization has on the environment. The results present what actions organizations have taken and what are they interested in the future, in using digitalization to reduce environmental impacts with both indirect and structural and behavioral effects. Regarding indirect impacts of digitalization, the CGI sustainability team, including myself, was especially interested in knowing how organizations view digital solutions of remote work, electronic processes, energy use optimization and digital supply chain management to improve their environmental performance.

Figure 15 presents the current use and future interest in four different digital solutions in reducing an organization's environmental impact. Remote work and electronic processes were very common in respondent organizations, since 86 % (n = 214) of respondents reported to use remote work, and 88 % (n = 218) electronic processes, in environmental impact reduction.

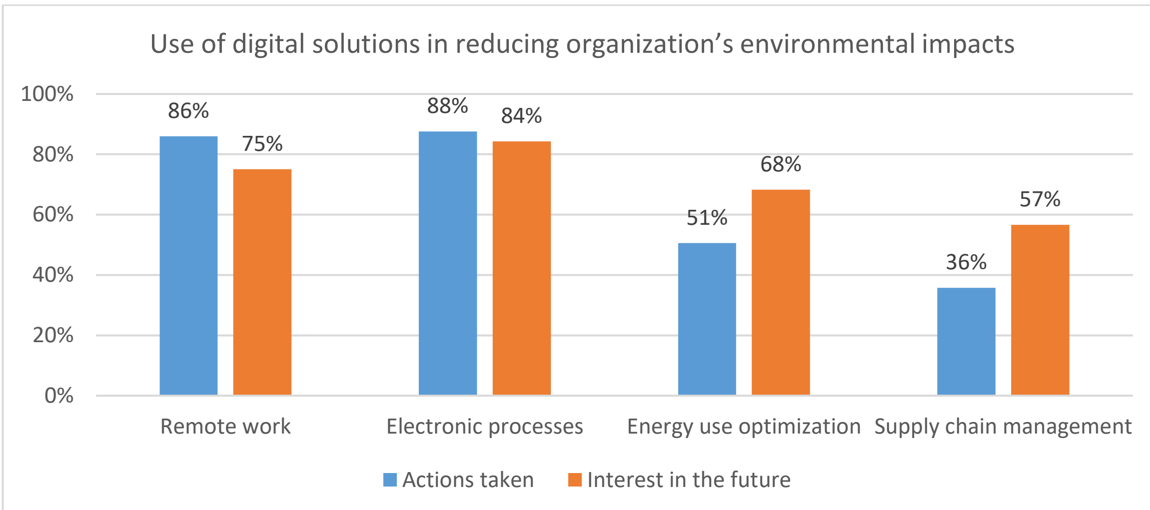


Figure 15. Use of digital solutions in reducing organization's environmental impacts

In contrast to all other questions in the survey, there was less interest in the future for remote work and electronic processes compared to current use, or 75 % (n = 187) and 84 % (n = 210) respectively. The reason could be that these technologies are so common that organizations view that they should focus on other areas in the future. However, most of the organizations that had already taken action regarding remote work or electronic processes, reported interest in those also in the future. Out of the 214 respondents that reported actions taken on remote work, 81 % (n = 174) were interested in it also in the future. This is in contrast to organizations that had not taken any action on remote work yet. Only 37 % (n = 13) out of 35 organizations that had not used remote work were interested in it in the future. Same holds for electronic processes. Out of the 218 respondents that reported actions taken on electronic processes, 88 % (n = 192) showed interest in it in the future. Only 58 % (n = 18) out of

31 organizations that had not used electronic processes for environmental impact reduction were interested in it in the future.

There was much less action taken regarding the use of supply chain management and energy use optimization in reducing organizations' environmental impacts. Only 51 % (n = 126) and 36 % (n = 89) of respondents reported currently using those. There was more interest in energy use optimization in the future, according to 68 % of respondents (n = 170), and supply chain management according to 57 % of respondents (n = 141).

Table 5A presents differences regarding digital solution usage depending on organizational characteristics or respondent position. Since there were so many findings on supply chain management and industrial classifications, they are presented later in table 5B. In table 5A, the public sector differs from the private sector in an interesting way regarding remote work. Municipalities had so far used remote work less that the private sector, and the government was more interested to use remote work in the future compared to the private sector. People working in an environmental or responsibility role mentioned having taken organizational actions to reduce environmental impacts through electronic processes only about one third compared to all other respondents. Supply chain management (SCM) is the one solution that had multiple divisions depending on organizational characteristics. First, government had both much fewer actions taken and interest in the future on SCM compared to the private sector. In contrast, international organizations had taken much more action regarding SCM compared to Finnish organizations.

Table 5A. Differences regarding the use of digital solutions in reducing environmental impacts depending on organizational characteristics or respondent position. Top rows present the independent variables and left columns the explanatory variables. The first number describes the odds ratio and the number in parenthesis is the p-value.

<table>
<tr><th rowspan="2"></th><th rowspan="2"></th><th colspan="2">Employer sector: below sectors are compared to private sector</th><th rowspan="2">Respondent position: Environmental and responsibility roles are compared to others</th><th colspan="2">Organization's internationality: below values are compared to Finnish organization</th></tr>
<tr><th>Municipality</th><th>Government</th><th>International organization, headquarters not in Finland</th><th>International organization, headquarters in Finland</th></tr>
<tr><td rowspan="2">Remote work</td><td>Actions taken</td><td>0.43 (p = 0.039)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Interest in the future</td><td></td><td>2.55 (p = 0.024)</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Electronic processes</td><td>Actions taken</td><td></td><td></td><td>0.32 (p = 0.016)</td><td></td><td></td></tr>
<tr><td>Interest in the future</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Supply chain management</td><td>Actions taken</td><td></td><td>0.24 (p = 0.0003)</td><td></td><td>2.53 (p = 0.037)</td><td>3.48 (p = 0.002)</td></tr>
<tr><td>Interest in the future</td><td></td><td>0.37 (p = 0.002)</td><td></td><td></td><td></td></tr>
</table>

Table 5B shows the differences on SCM depending on the industry of the respondents. Almost all other industries were more likely to have actions taken in improving environmental performance with SCM compared to public administration and defense. Digital solutions other than SCM did not have statistically significant differences depending on industry.

Table 5B. Differences regarding the use of digital solutions in reducing environmental impacts depending on industrial classification. Industrial classifications are in left column. The first number describes the odds ratio and the number in parenthesis is the p-value.

	Supply chain management	
Industrial classifications: below industries are compared to public administration and defense	**Actions taken**	**Interest in the future**
Wholesale and retail trade	17.88 (p = 0.00005)	13.55 (p = 0.014)
Human health and social work activities	8.38 (p = 0.0001)	
Administrative and support service activities	8.53 (p = 0.002)	
Manufacturing	5.48 (p = 0.002)	
Information and communication	3.79 (p = 0.020)	

Figure 16 presents the different environmental aspects organizations focused on when reducing their environmental impacts with digital solutions. In both actions taken and interest in the future, the most significant environmental aspect was energy, followed by waste, materials, and finally emissions. The differences between environmental impacts were not that prominent in future interest, with 78 % (n = 194) of respondents being interested in energy and 61 % (n = 151) being interested in emissions. On the other hand, differences between actions taken on different environmental aspects were higher, since the aspect with most actions taken (energy) had 72 % (n = 179) coverage of respondents, and least actions taken (emissions) received only 38 % (n = 95) coverage.

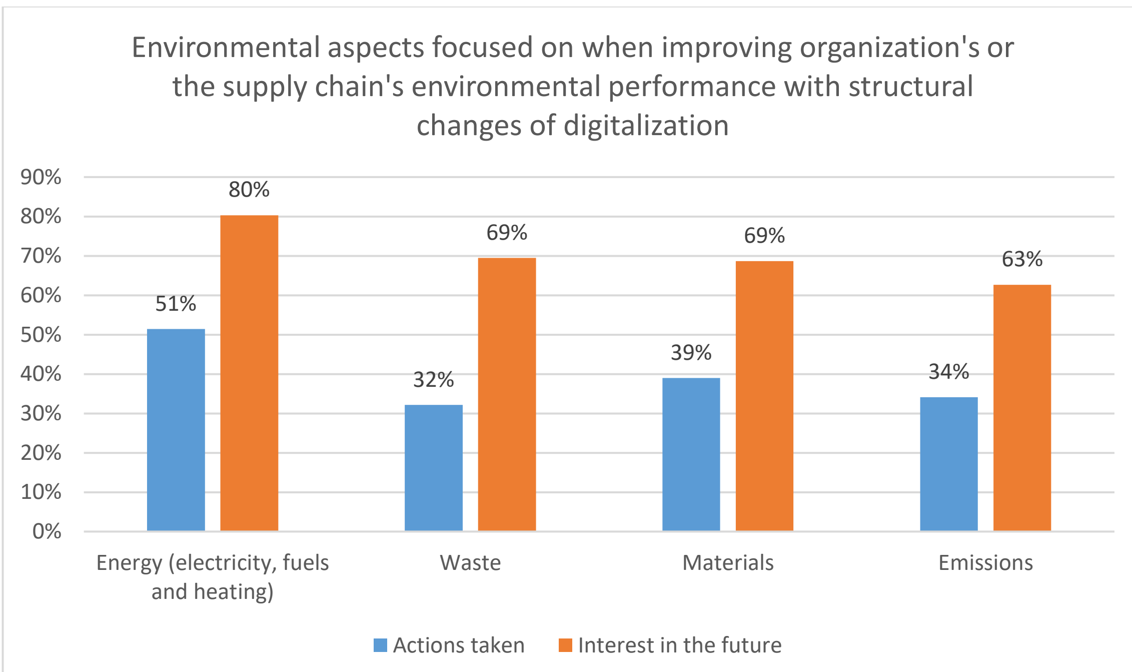


Figure 16. Environmental aspects focused on when improving organization's environmental performance with digitalization's indirect effects.

Regarding actions taken, 13 % of respondents (n = 33) reported none. 20 % of respondents (n = 51) reported actions taken on one of the environmental aspects, 27 % (n = 68) on two, 21 % (n = 53) on three and 18 % (n = 44) on all four of the mentioned aspects. Compared to actions taken, much more organizations mentioned all four aspects regarding future interests. 12 % (n = 30) of respondents reported interest in the future on none of the environmental aspects. 11 % (n = 28) reported interest on one environmental aspect, 13 % (n = 32) on two and 19 % (n = 48) on three. Clearly the highest number of respondents, 45 % (n = 111), reported interest in the future on all of the mentioned environmental aspects.

Table 6 presents differences regarding indirect impact environmental aspects depending on organizational characteristics or respondent position. Similarly as in direct impact aspects in table 4, there was no sustained focus of both actions taken and interest in the future for any organizational characteristic regarding any environmental aspect. Statistically significant findings were very isolated. Both the information and communication and financial and insurance activities industries were many times as likely to have actions taken regarding materials compared to public administration and defense. Moreover, information and communication industry was almost four times as likely to have taken action on emissions than public administration and defense. However, financial and insurance activities were only a third as likely to have interest in energy compared to public administration and defense. When it comes to other characteristics than industries, international organizations that have headquarters outside of Finland were almost three times as likely to have taken action regarding waste compared to Finnish organizations. Municipalities were almost three times as likely to be interested in the future in energy compared to the private sector. On the other hand, regarding the public sector, government organizations were less than half as interested in emissions as private sector companies. No other statistically significant differences were found.

Table 6. Differences regarding environmental aspects of indirect digitalization usage depending on organizational characteristics or respondent position. Top rows present the independent variables and left columns the explanatory variables. The first number describes the odds ratio and the number in parenthesis is the p-value.

		Industrial classifications: below industries are compared to public administration and defence		Internationality: International organization, headquarters not in Finland is compared to Finnish organization	Employer sector: below sectors are compared to private sector	
		Information and communication	Financial and insurance activities		Municipality	Government
Waste	Actions taken			2.78 (p = 0.039)		
	Interest in the future					
Enery	Actions taken					
	Interest in the future		0.30 (p = 0.016)		2.96 (p = 0.012)	
Materials	Actions taken	4.62 (p = 0.012)	2.52 (p = 0.034)			
	Interest in the future					
Emissions	Actions taken	3.74 (p = 0.019)				
	Interest in the future					0.40 (p = 0.005)

Regarding structural and behavioral changes, it was asked to what environmental aspects respondents focus on when reducing the environmental impact of their organization or larger supply chain. Figure 17 presents these results. Overall, the results are quite similar compared to figure 16. There was slightly less action taken on all of the aspects, but slightly more interest on all aspects except emissions.

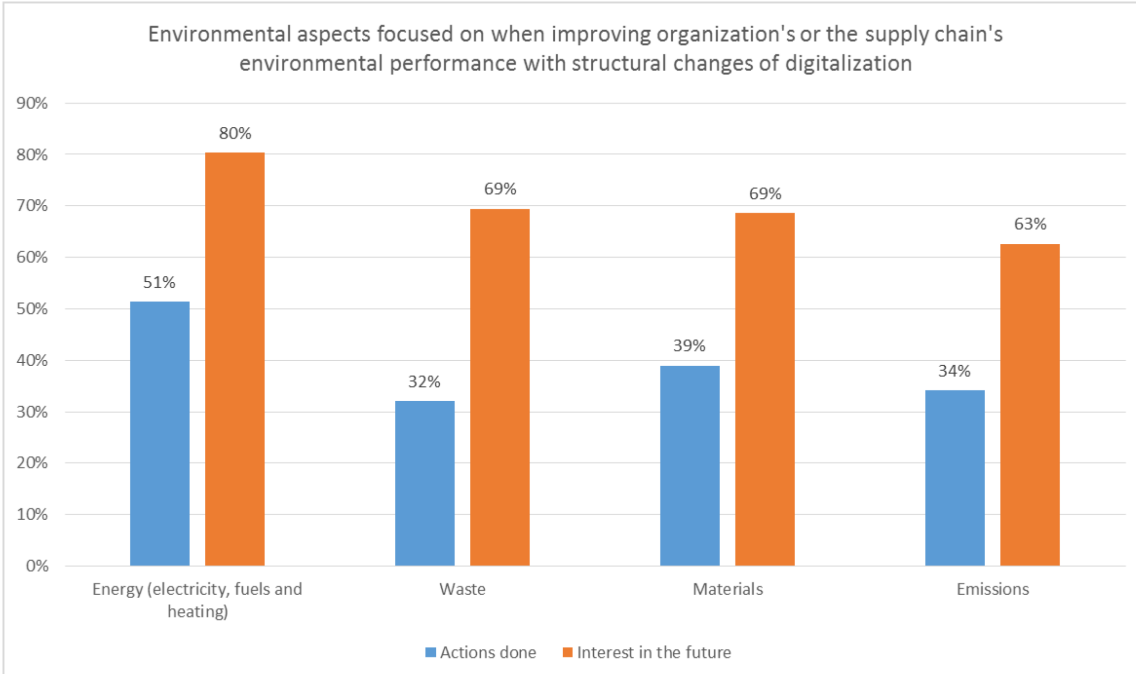


Figure 17. Environmental aspects focused on when improving organization’s or the supply chain’s environmental performance with structural changes of digitalization.

Respondents were distributed quite evenly between having taken action on one or more aspects. 36 % of respondents (n = 90) reported no actions taken. 15 % of respondents (n = 37) reported actions taken on one of the environmental aspects, 19 % (n = 48) on two, 16 % (n = 39) on three and 14 % (n = 35) on all four of the mentioned aspects. Similarly as in figure 16, many respondents were interested on all four environmental aspects. 9 % (n = 23) of respondents reported interest in the future on none of the environmental aspects. 10 % (n = 25) reported interest on one environmental aspect, 17% (n = 42) on two and 18 % (n = 45) on three. Clearly the highest number of respondents, 46 % (n = 114), reported interest in the future on all of the mentioned environmental aspects.

Regarding structural changes, there were few statistically significant differences depending on organizational characteristics or respondent position. The only differences concerned industrial classifications. In professional, scientific and technical activities it was 4.27 times as likely, and in human health and social work activities 2.93

times as likely, to have actions taken on materials ($p = 0.026$ & $p = 0.037$) compared to public administration and defense. Furthermore, it was 3.19 times as likely to have actions taken on emissions in the information and communication industry compared to public administration and defense. Moreover, in financial and insurance activities it was only 0.36 times as likely to have interest in the future on energy ($p = 0.034$) compared to public administration and defense. No other statistically significant differences were found.

5. DISCUSSION

5.1 Main Findings

5.1.1 Motivation for environmental sustainability in Finnish organizations

According to the respondents of this study, cost savings is clearly the most motivating factor for organizational or larger supply chain environmental impact reduction in their organizations. Environmental performance and cost savings go hand in hand in many cases, since savings in energy consumption, material usage and waste usually mean less costs as well. The results are in line with other empirical studies by McKinsey (Bonini & Görner 2011) and MIT Sloan Management Review (Haanaes et al 2011). On the other hand, Finnish studies regarding corporate responsibility (FIBS 2016) and carbon neutrality (Sitra 2015) had many other factors such as brand and regulation surpassing cost savings as higher motivating factors.

Reputation, regulation and organizational values or strategy were also among the most motivating factors by the respondents of this study. Reputation and regulation are external factors while organizational values or strategy is more internal in nature (Jenkin et al. 2011). Reputation affects the social legitimacy of organizations and decline in reputation has a high risk of affecting the economic performance of organizations as well. Regulation, on the other hand, is more coercive external factor motivating for environmental performance improvement. Regulatory motivation can be either direct or indirect depending on whether respondents interpret the regulation as current or as expected regulation in the future. As Bose & Luo (2011) note that organizations can try to get ahead of the regulatory curve to such a degree that they can preempt future legislation altogether. Organizational values or strategy is an internal motivation that indicates interest in environmental sustainability itself without external reasons. It is of course possible that, in the end, strategy for environmental sustainability is based on mainly economic motives. Still, having such strategy would mean that organization would mainly refer to sustainability as value rather than as just economic incentive. Risk management, differentiation from competitors and imitation of competitor actions were the lowest mentioned motivating factors.

When this study is compared to the mix of other empirical studies, we can conclude that cost savings as one of the top motivations is in line with some studies (Bonini & Görner 2011, Haanaes et al 2011, EIU 2009), but not all (FIBS 2016, Sitra 2015). Reputation or brand and values, goals or business fundaments seems to be high in almost all of the studies. Regulation was high motivational factor in this study, and in Sitra (2015) survey. In this study, respondents were not classified into sustainability leaders and others. Thus, it was not possible to confirm or deny the claims that sustainability leaders are more driven by internal motivation and business focus compared to all others (Haanaes et al 2011, EIU 2009).

5.1.2 Environmental sustainability through digitalization in Finnish organizations

According to the results, there is clear general agreement that digitalization and environmental sustainability are connected and digitalization's importance for environmental performance is growing in the future. Furthermore, organizations are trying both to reduce direct environmental impacts of IT equipment and use indirect and structural effects to improve environmental performance. In addition, organization have already taken quite a lot of different types of actions to reduce environmental impact and but are even more interested in those in the future.

Perceptions towards digitalization and sustainability were very positive according to the survey. 90 % of the respondents agreed somewhat or completely that digitalization and sustainability are highly connected. There seems to be still some work to be done in many Finnish organizations, since 47 % of the respondents could not agree with the statement that currently digitalization and sustainability are highly connected in their own organization. However, it is interesting that 15 % agreed with that statement completely, which means that they should have lot of actions taken to improve environmental performance through digitalization. In addition, 83 % of respondents agreed that in the future the connection between digitalization and sustainability will be more important in their organization. This finding was supported with large interest towards digitalization’s environmental aspects in the future.

When it comes to the reduction of direct impacts of IT, according to Mingay (2007) and Agrawal & Agrawal (2012) organizations should implement policies aiming for sustainability in the procurement, use and disposal phases. Authors continue that there are significant opportunities for efficiency improvements and more sustainable practices regarding multiple environmental aspects and multiple devices including data centers.

The survey respondents were asked about which equipment, which life-cycle stages and which environmental impacts were in their interest and what actions they had already taken. Overall, 53 % of respondent organization had already taken some actions and 85 % reported at least one environmental aspect they were interested in the future in direct environmental performance of IT. There were quite significant differences in what equipment, life-cycle stages and environmental aspects organizations have focused on so far and what their interests are in the future.

Regarding IT equipment, 40 % of respondents had already improved environmental performance of work stations and printers. Actions regarding servers, cellphones and network equipment were only taken on 27 %, 18 % and 12 % of respondent organization respectively. Interest in the future was also somewhat spread out between different equipment. Work stations and printers were interesting according to 57 % and 54 % of respondents, but servers, cellphones and network equipment received only 44 %, 38 % and 31 % of respondent interest respectively. One might think that different industries would explain differences in IT equipment focus, but there were rather few differences between organizational characteristics in the results. It could be that respondents do not know the environmental impacts of cell phones and network equipment as majority of organizations did not express interest towards those even in the future or it might be that only work stations and printers are focused on due prioritization.

In life-cycle stages, organizations showed clear pattern in both actions taken and interest in the future – the order of most responses was from disposal to use and purchase. However, the differences were not that large – differences in taken actions were between 33 % and 43 % and in future interests between 56 % and 66 %. Nevertheless, results are interesting in that organizations seem to focus most on the life cycle stage that has the least effect on the overall environmental impacts. With disposal you can basically only affect the waste that IT equipment produce. On the other hand, purchase criteria enable possibilities to affect energy use, material use and also waste.

The environmental aspect that had most actions taken was waste with 43 % of respondents, which is in line with the fact that highest amount of life-cycle actions taken was on disposal. In addition, 39 % reported actions taken on energy. Actions regarding materials and emissions were mentioned only 27 % and 14 % of respondents respectively. In the future, over 70 % of respondents were interested in waste and energy, 59 % are interested in materials and only 43 % in emissions.

In relation to indirect and structural effects of digitalization in improving environmental sustainability, Chen et al. (2008) and Dao et al. (2011) discusses the roles of automating, informating and transforming tasks and processes. Literature presents multiple digital solutions from automation in city lighting (CGI 2014a) and waste fill monitoring (Enevo 2016) to predicting consumption quantities for food service providers (CGI 2017), remote diagnostics (Yang et al. 2009), timely and precise information about public transport availability (Kramers et al. 2014), remote work (e.g.

Kitou & Horvath 2003, Hiselius et al. 2015) and e-commerce (Fichter 2003, Edwards et al. 2009) that help in reducing energy, materials, emissions and waste.

The respondents were asked about use of certain digital solutions for environmental sustainability and environmental aspects. Digital solutions covered were remote work, electronic processes, energy use optimization and supply chain management. Remote work and electronic processes were used in 85 % of respondent organizations to improve environmental performance. Energy use optimization was used in around half of the organizations and digital supply chain management was used for environmental performance in only 36 % of organizations. Interestingly remote work and electronic processes were the only responses in the whole survey where reported future interest was lower – 75 % and 84 % respectively – than actions taken. This suggests that these solutions might be somewhat mature since at least few organizations seem to feel that they have already done enough regarding them. Future interest in energy use optimization and supply chain management were reported in 68 % and 57 % of respondents respectively. These are higher compare to actions taken, but also lower compared to future interest in remote work and electronic processes. As such, no strong conclusion can be made about maturity of different solutions.

Results regarding environmental aspects were somewhat similar in both indirect and structural effects of digitalization. The order of most interest was the same in both: energy (concerning electricity, fuels and heating), waste, materials and emissions. Interest in the future was quite evenly spread and high overall, since even the fewest mentioned emissions had 61 % and 63 % responses in indirect and structural effects respectively and highest mentioned energy received 78 % responses regarding indirect effects and 80 % regarding structural effects. Even actions taken were high according to the respondents. 72 % reported that digitalization was already used to indirectly improve energy aspect, while waste had been in focus for 54 % of organizations, materials for 45 % and emissions for 38 %. Quite similarly digitalization was reported to be already used in larger supply chain to improve performance regarding energy in half of the organizations and between 30 % and 40 % reported actions already regarding waste, materials and emissions.

All in all, results show that many Finnish organizations have both taken actions already and are even more interested in the future about many aspects of digitalization and sustainability. Only around half of the respondents had already taken actions to reduce direct environmental impacts of IT equipment but large majority were interested in it in the future. Most mentioned concerns were regarding work stations and printers, energy and waste environmental aspect and disposal life-cycle stage. Regarding digital solutions remote work and electronic processes were reported to be used in 85 %, energy use optimization in half and supply chain management in over third of organizations.

5.1.3 Differences within organizational factors and respondent positions

There were some interesting differences between organizational factors and respondent position in the survey. However, there were no consistent patterns regarding actions taken or future interest depending on organization types and thus it is not possible to draw any strong conclusions. On the other hand, it is interesting result, that there were all in all quite few differences. Thus, at least according to this survey, there seems to be no clear indication, that any industry, employer sector or internationality is overall significantly better with digitalization and sustainability compared to others.

Regarding motivational factors for environmental sustainability, there were significant differences between public and private sector organizations. Competitor, customer and business-related motivations were not that relevant for public sector organizations – both municipalities and government – and since they account for nearly half of the respondents, they affect the overall results somewhat. When looking at only private sector organizations, customer expectations become the third highest motivational factor up from the fifth place in overall results and differentiation from competitors changed from 11th to 7th place. Furthermore, private sector reported statistically significantly higher motivation in the following factors as well: imitation of competitor actions, new business opportunities and reputation. Finally, it was also interesting that international organizations, especially those that had headquarters outside Finland reported higher motivation on almost all factors compared to Finnish organizations. However, this motivation was not shown consistently later on in higher amount of actions taken or higher future interest on digitalization and sustainability. Some previous surveys (Bonini & Görner 2011, Sitra 2015) have found indications that energy, manufacturing and other environmentally intensive industries are more concerned about sustainability compared to other organizations, probably due to higher regulation and closeness of the issue to their business. However, similar tendency within industries was not confirmed in this study.

Regarding the reduction of direct impacts of IT equipment, there were some interesting differences between industries and employer sector. For example, organizations in information and communication industry were many times as likely to have both actions taken and future interest towards servers and network equipment compared to public administration and defense, but interestingly only 0.14 times as likely to have actions taken on work stations. In addition, human health and social work activities industry showed significantly higher interest in network equipment and disposal life-cycle stage compared to public administration and defense. Municipalities, on the other hand, showed higher future interest in many responses compared to private sector. Municipalities were two times as likely to have future interest in work stations, printers, purchase life-cycle stage and waste environmental aspect compared to private sector.

In respect to how digitalization’s indirect and structural effects are used in organization to improve environmental performance, there were also some differences depending on organizational characteristics. It was only less than half as likely for municipalities to have already used remote work while government showed more than twice as much future interest towards it compared to private sectors. In addition, there were many differences regarding supply chain management (SCM) usage for environmental sustainability. First, government reported much less both actions taken and interest in the future for SCM compared to private sector. Second, international organizations reported much more action taken regarding SCM compared to Finnish organizations, but interestingly no difference were found on future interest. Third, within industries, wholesale and retail, health, administrative and support, manufacturing and information and communication all reported much more actions taken on SCM compared to public sector and defense.

Regarding environmental aspects that organizations consider in both indirect and structural effects of digitalization, there were a couple of significant differences within industries, employer sector and internationality. In both indirect and structural effects information and communication industry was over three times as likely to have actions taken regarding emission reductions, while financial and insurance activities were only around third as likely to have future interest in energy compared to public administration and defense. In addition, only in indirect effects both of the mentioned industries were many times as likely to have actions taken on material usage compared to public administration and defense. Furthermore, international organization having headquarters outside Finland reported almost three times as likely to have actions taken on indirect waste reduction compared to Finnish organizations. Finally, regarding future interest in indirect effects, municipalities reported almost three times as likely to have interest in energy and government less than half as likely to have interest in emissions compared to private sector.

There were almost no differences in the survey results depending respondent position. Managers or leaders reported twice as much actions taken regarding materials of IT equipment compared to people in expert roles. In addition, people working in environmental or responsibility roles reported higher motivation by risk management and it was only 0.32 times as likely for them to mention actions taken to improve environmental sustainability by electronic processes compared to people working in other fields. It might be that people working within environment and sustainability remember risks related to environment better than others. Furthermore, they might be more critical when evaluating whether electronic processes have really been used for environmental sustainability or for something else instead. It is interesting result that motivation, perception, interest and reporting on actions taken were very similar between different roles in the organizations.

5.2 Theoretical Implications

To my knowledge this is the first study on digitalization and sustainability in Finnish organizations. There is existing literature on both digitalization in organizations and sustainability in organizations individually, but this research is groundbreaking in studying their combination in organizations in Finland.

Empirical research on the motivation for environmental sustainability adds to the existing literature. There have rather few surveys on environmental sustainability motivation for Finnish organizations and the exact issue being studies has varied from responsibility to carbon neutrality. These topics are close to environmental sustainability, but there are also considerable differences in the definitions that also might explain the differences in results.

There has been a gap in scientific literature on the on the perception, actions taken and future interest on digitalization and sustainability in organizations. In this study the theoretical framework combines looking into direct, indirect and structural effects of digitalization, comparing actions taken already to future interest and viewing the environmental aspects of energy, waste, materials and emissions.

The breaking down of environmental effects of ICT into direct, indirect and structural effects by Berkhout and Hertin (2004) helps in analyzing both the positive and the negative effects that digitalization has on the environment. Comparing actions taken and future interest shows what types of actions are mature, what are coming up and what are missing from the perspectives of different organizations. Viewing different aspects of environmental sustainability helps clarify what sustainability means for organization. This perspective has not been fully covered in many studies regarding ICT and environmental sustainability in organizations. Furthermore, this study covers the differences within organizational factors, which most of the other studies regarding ICT and sustainability do not analyze.

5.3 Practical Implications

People working in fields of digitalization and sustainability in Finnish context will benefit from the implications of this study. First, knowing what motivates and what doesn't motivate organizations for environmental sustainability may help multiple experts in consulting, sustainable investing, non-governmental organization, and sustainable product and service provider companies to understand their customers and help them in their marketing and selling. According to the survey cost savings, reputation management, customer expectations and new business opportunities might be the kind of selling points that organizations are interested in. In addition, policy makers should notice that regulation was the third highest ranked motivating factor in the survey.

Also, better understanding on what organizations have already done and what are their future interests is useful information for many stakeholders in digitalization and sustainability fields. For example, electronic processes and remote work are highly used solutions already in many organizations, but there was high amount of interest in developing those solutions further. IT equipment providers might be interested to know that in work stations and printers there was quite high interest for environmental sustainability, but not so much in cellphones and network equipment. Little more than half of the organizations also reported environmental interest in purchase and use phase, suggesting that those should be developed in IT equipment. Furthermore, IT equipment disposal companies might have interesting business opportunities within the 66 % of organization that reported interest in environmental sustainability of IT equipment disposal. Even though it is hard to think that any large organization could function without servers, whether owned or purchased as a service, only less than third of organizations showed interest in their sustainability in the future. Thus, those companies willing to sell their cloud servers on environmental sustainability performance should note that they need to raise interest in the topic first for most organizations. Also, it might be useful for many to know that solutions improving energy efficiency was interesting to around 80 % of organizations, while roughly 70 % were interested in waste and materials reductions and little over 60 % were focused on emissions reductions.

Knowledge about the differences or lack of thereof might also interest many practitioners. As presented in the results some industries and employer sectors are more interested in certain equipment, life cycle stages, environmental aspect and digital solutions. For example, people working in municipalities should note that remote work is much less used solution compared to private sector, so municipalities have a room for improvement in this regard.

5.4 Recommendations for Further Research

This study focused on the question of what. What are the motivating factors, what actions have been taken, what future interests are and what differences are there within organizational factors? Further research could be focus on understanding more on the underlying reasons of why. Examples of further research questions are why some factors motivate organizations more than others, why organizations are interested in certain aspects but not others and why organizations have or doesn't have differences between organizational factors. Furthermore, this study has focused on medium and large organizations in Finland and the scope in further research could be expanded from these choices.

Most respondents reported agreed that in the future the connection between digitalization and environmental sustainability will be more important. If promoting digitalization and sustainability is seen as important task for the society, further research is also needed to understand the barriers and opportunities that organizations face in that regard.

Although this study covered direct, indirect and structural effects if digitalization, there were more multiple-choice questions regarding direct impacts than others. This is because environmental impacts of ICT equipment is more focused scope compared to all environmental impacts of organizations. Thus, more research is needed on the indirect and structural effects of digitalization. Better understanding of all the different digital solutions would be needed, but that topic is difficult to study since it is so large in scope. In addition, new solutions in new use cases are emerging all the time. Despite the challenge, analytical framework could be developed to understand the types of solutions that are used and why certain organizations or industries might be more innovative in combining digitalization and environmental sustainability compared to others.

6. CONCLUSIONS

6.1 Summary of Results

The objective of this study was to understand how different organizations view digitalization in improving environmental sustainability. This objective was divided into three research questions. The following summarizes the results for these questions.

What motivates Finnish organizations for environmental sustainability?

According to the survey, the respondents reported being most motivated to reduce the environmental impacts in their organization and larger supply chain by cost savings. Savings in energy consumption, material usage and waste usually mean less costs as well. In addition, high motivational factors included reputation, regulation, which are more external motivations and organizational values or strategy, which is more internal motivation. Risk management, differentiation from competitors and imitation of competitor actions were the lowest mentioned motivating factors. When this study is compared to the mix of other empirical studies, we can conclude that cost savings as one of the top motivations is in line with some studies, but not all. Reputation or brand and values, organizational goals or business fundaments seems to be high in almost all of the studies.

How have Finnish organizations improved or are interested in improving environmental sustainability through digitalization?

According to the results, there is high agreement to the statement that digitalization and environmental sustainability are connected and that digitalization's importance for environmental performance is growing in the future. In addition, many organizations have some actions taken and usually even more interest in the future in improving sustainability through digitalization. Actions taken and future interest covers the reduction of direct environmental impacts of IT equipment and using indirect and structural effects of digitalization to improve environmental performance. Moreover, organizations are quite interested in all of the measured environmental aspect, which were energy, materials, waste and emissions.

Perceptions towards digitalization and sustainability were very positive according to the survey. 90 % of the respondents agreed somewhat or completely that digitalization and sustainability are highly connected. There is still some work to be done in Finnish organizations, since 47 % of the respondents could not agree with the statement that currently digitalization and sustainability are highly connected in their own organization. When it comes to reducing the direct environmental effect of IT, 53 % of respondent organization had already taken some actions and 85 % reported at least one environmental aspect they were interested in the future. Most mentioned actions taken and future interests were regarding work stations and printers, energy and waste environmental aspect and disposal life-cycle stage. When it comes to indirect effects of digitalization, there were much more actions taken. For example, remote work and electronic processes were used in 85 % of respondent organizations to improve environmental performance. In addition, 87 % reported at least one environmental aspect they are already focused on in reducing through digital solutions. Finally, 45 % of the respondents reported future interest to reduce all of the mentioned environmental aspect through digitalization.

What are the differences in motivation, perceptions, actions and interests depending on organizational characteristics and respondent position?

There were surprisingly few differences in motivation, perceptions, actions and interests depending on organizational characteristics and especially respondent position. People working in environmental or responsibility roles reported higher motivation by risk management and it was only 0.32 times as likely for them to mention actions taken to improve environmental sustainability by electronic processes compared to people working in other fields.

Regarding motivation factors for environmental sustainability, there were significant differences between public and private sector organizations. Private sector reported statistically significantly higher motivation compared to both government and municipalities in the following factors: customer expectations, differentiation from competitors, imitation of competitor actions, new business opportunities and reputation. In addition, international organizations having operations in Finland reported higher motivation on almost all factors compared to Finnish organizations.

Many differences regarding actions and interests were so isolated, that no conclusions could be drawn from them. However, some interesting results were also found. For example, regarding reduction of direct effects of IT, municipalities were roughly two times as likely to have future interest in work stations, printers, purchase life-cycle and waste environmental aspect compared to private sector. In respect to how digitalization’s indirect and structural effects were used in organization to improve environmental performance, it was only less than half as likely for municipalities to have already used remote work while government showed more than twice as much future interest towards it in the future compared to private sectors. In addition, there were many differences regarding supply chain management (SCM) usage for environmental sustainability maybe due to importance of supply chains for the organization purpose. Government organizations were not that focused on SCM compared to private sector and international organizations reported more actions compared to Finnish organizations. Finally, regarding future interest in indirect effects, municipalities reported almost three times as likely to have interest in energy and government less than half as likely to have interest in emissions compared to private sector.

Based on the results of this survey, there seems to be no clear indication that any industry, employer sector or internationality could be said to be overall significantly more focused on digitalization and sustainability compared to others.

6.2 Limitations of the Study

Literature review in this study concerns digitalization and sustainability in public and private sector organizations, but empirical part focuses on medium and large Finnish organizations.

First, it is not possible to draw conclusions from the empirical part regarding small organizations or organizations in other countries. It is possible that smaller organizations and organizations in other countries would give very different results on motivation for environmental sustainability, perception on the connection between sustainability and digitalization, actions taken and future interest in different types of effects. Literature suggests that large organizations are expected to be more concerned with environmental sustainability and invest more into digitalization due to more resources, higher regulation burden and higher customer pressure (Stanwick & Stanwick 1998, Baylis et al. 1998, Collins et al 2007, Bose & Luo 2011, Hörisch et al 2015).

Second, data cannot be argued to represent the whole spectrum of Finnish private and public medium and large organizations. Data was gathered by the survey that was open in CGI Finland company web page, email about the survey was sent to CGI customers including 6,923 addresses, the survey was spread also in social media and some partner organizations also spread the survey in their network. Thus, the reach of the survey can be argued to be quite high. However, claiming that this is a fair representation of all Finnish medium and large organizations would be an overstatement. Thus, too strong conclusions should not be drawn from this study. Instead it should be understood that this thesis provides interesting insights into the motivation for environmental sustainability, and perception, actions taken and future interests in sustainability through digitalization that, at least some, Finnish medium and large organizations share.

6.3 Reliability and validity

Validity is concerned with the accuracy of our measurement and can be looked from the perspectives of content validity, internal validity and external validity. Reliability, on the other hand, is concerned with the consistency of our measurement, meaning the degree to which the questions used in a survey elicit the same type of information each time they are used under the same conditions. (Mora 2011)

The reliability of the survey was improved by pretesting the survey with multiple stakeholders inside CGI and partner organizations. Thus, it was tried to limit the possibilities of different interpretations of the questions. Ultimately reliability could only be tested by replicating the study and seeing if similar results would be got.

Validity of surveys can be looked at from three perspectives. First, content validity is related to the ability to create questions that reflect the issue being researched and make sure that key related subjects are not excluded (Mora 2011). Digitalization and sustainability are very complex topics so the focus had to be very narrow. Thus, no conclusions should be drawn outside the questions asked and it is possible that overall picture would change is additional questions were also asked. Secondly, internal validity is about whether the questions we pose can really explain the outcome we want to research (Mora 2011). To preserve internal validity, only statistically significant findings were reported. Thirdly, external validity refers to the extent in which the results can be generalized to the target population the survey sample is representing (Mora 2011). As was already discussed in limitations of the study, one should not draw conclusion that this study is representative of all Finnish public and private sector medium and large organizations. Instead, the thesis provides interesting insights into how environmental sustainability is improved through digitalization in some Finnish organizations.

Surveys validity can also be reduced by multiple biases (DeFranzo 2012). First, respondents may not feel comfortable providing answers that present themselves in an unfavorable manner. This was tackled by anonymity of organizations and the respondents. Second, respondents may not be fully aware of their reasons for any given answer because of lack of memory on the subject, or even boredom. Survey was quite long and topics covered were complex, which might compromise validity due to exhaustion and lack of understanding. However, the fact that people working in environmental and responsibility fields answered the questions similarly as others suggests that majority of respondents understood what they were asked about. Finally, the number of respondents who chose to respond to the survey might have been different from those who chose not to respond, thus creating bias. This is a true limitation in the research that could be overcome by replicating the survey with even more data.

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Appendix 1: Survey questions in Finnish

Kysely toteutettiin vain verkossa ja siinä oli muitakin kysymyksiä alla olevan lisäksi, mutta alle on kirjattu tämän tutkimuksen kannalta oleelliset kysymykset ja vastausvaihtoehdot.

Digitalisaatio ja kestävä kehitys -kysely

Tämä CGI:n tukema Aaltoyliopistossa tehtävän diplomityön kysely käsittelee sitä, miten digitalisaatio ja kestävä kehitys kytkeytyvät toisiinsa suomalaisissa yrityksissä ja julkisen sektorin organisaatioissa.

Kyselyyn pyydetään vastauksia eri taustaisilta henkilöiltä useissa organisaatioissa. Voit siis levittää kyselyä omassa organisaatiossasi ja verkostossasi, mutta vastaa ihmeessä myös itse, vaikka aihe ei olisikaan sinulle kaikilta osin tuttu.

Tutkimukseen vastaaminen vie n. 10-15 minuuttia. Vastaukset käsitellään nimettöminä ja luottamuksellisesti. Yksittäisen vastaajan, yrityksen tai organisaation tietoja ei voi tunnistaa tutkimustuloksista.

Digitalisaatiolla tarkoitetaan digitaalisten teknologioiden hyödyntämistä liiketoimintamallien muutoksessa, uuden liikevaihdon luomisessa ja arvonluonnin mahdollistamisessa. Kestävä kehitys on kehitystä, joka tyydyttää nykyhetken tarpeet viemättä tulevilta sukupolvilta mahdollisuutta tyydyttää omat tarpeensa.

Tässä tutkimuksessa keskitytään erityisesti kestävän kehityksen ympäristöllisiin näkökohtiin, kuten energiaan, päästöihin, materiaalien käyttöön ja jätteisiin. Kyselyssä tarkastellaan digitalisaation mahdollistamien IT-investointien suoria ympäristövaikutuksia, epäsuoria ympäristövaikutuksia ja digitalisaation mahdollistamaa laajempaa toimintatapojen muutosta.

Osittain samat kysymykset toistuvat eri osioissa. Tämän tarkoituksena on selvittää eroavatko näkemykset eri vaikutuksia tarkasteltaessa. Lisäksi havainnoidaan eroja tehtyjen toimien ja tulevaisuuden näkemysten suhteen.

Tutkimuksen tuloksista toteutetaan tutkimusraportti, jonka kaikki tutkimukseen osallistuvat saavat halutessaan käyttöönsä.

Raportti toimitetaan halukkaille arviolta loppuvuodesta 2016.

Aloita vastaaminen painamalla Jatka-painiketta sivun oikeasta alakulmasta.

1. Organisaation toimiala, jossa tällä hetkellä työskentelet

( ) Maatalous, metsätalous ja kalatalous
( ) Kaivostoiminta ja louhinta
( ) Teollisuus
( ) Sähkö, kaasu ja lämpöhuolto, jäähdytysliiketoiminta
( ) Vesihuolto, viemäri ja jätevesihuolto, jätehuolto ja muu ympäristön puhtaanapito
( ) Rakentaminen
( ) Tukku ja vähittäiskauppa
( ) Kuljetus ja varastointi
( ) Majoitus ja ravitsemistoiminta
( ) Informaatio ja viestintä

( ) Rahoitus ja vakuutustoiminta
( ) Kiinteistöalan toiminta
( ) Ammatillinen, tieteellinen ja tekninen toiminta
( ) Hallinto ja tukipalvelutoiminta
( ) Julkinen hallinto ja maanpuolustus
( ) Koulutus
( ) Terveys ja sosiaalipalvelut
( ) Taiteet, viihde ja virkistys
( ) Kansainvälisten organisaatioiden ja toimielinten toiminta
( ) Jokin muu, mikä ____

2. Organisaation työnantajasektori

( ) Valtio
( ) Kunta
( ) Yksityinen
( ) Jokin muu, mikä ____

3. Organisaation kansainvälisyys

( ) Suomalainen organisaatio
( ) Kansainvälinen organisaatio, pääkonttori Suomessa
( ) Kansainvälinen organisaatio, pääkonttori muualla kuin Suomessa

4. Organisaation henkilömäärä Suomessa

( ) 1 – 10
( ) 11 – 50
( ) 51 – 250
( ) 251 –500
( ) yli 500

5. Organisaation henkilömäärä maailmanlaajuisesti

( ) alle 500
( ) 500 – 1000
( ) 1001 – 5000
( ) 5001 – 10000
( ) 10001 – 25000
( ) 25001 – 75000
( ) yli 75000

6. Oma asemasi tai roolisi organisaatiossa

( ) Liiketoimintajohto
( ) IT-johto
( ) Kehitysjohto
( ) Vastuullisuusjohto
( ) Ympäristöjohto
( ) Liiketoiminnan asiantuntija
( ) IT-asiantuntija
( ) Vastuullisuusasiantuntija
( ) Ympäristöasiantuntija
( ) Jokin muu, mikä ____

7. Digitalisaatiolla ja kestävällä kehityksellä on merkittävä yhteys

( ) täysin samaa mieltä
( ) jokseenkin samaa mieltä
( ) ei samaa eikä eri mieltä
( ) jokseenkin eri mieltä
( ) täysin eri mieltä

8. Organisaatiossani digitalisaatio ja kestävä kehitys kytkeytyvät nykyisin vahvasti toisiinsa

( ) täysin samaa mieltä
( ) jokseenkin samaa mieltä
( ) ei samaa eikä eri mieltä
( ) jokseenkin eri mieltä
( ) täysin eri mieltä

9. Tulevaisuudessa organisaatiossani digitalisaation ja kestävän kehityksen yhteys tulee korostumaan

( ) täysin samaa mieltä
( ) jokseenkin samaa mieltä
( ) ei samaa eikä eri mieltä
( ) jokseenkin eri mieltä
( ) täysin eri mieltä

Digitalisaation on ennustettu lisäävän teknisten laitteiden määrää ja käyttöä merkittävästi tulevaisuudessa. Tästä aiheutuu sekä negatiivisia että positiivisia ympäristövaikutuksia. Seuraavat kysymykset koskevat sitä, onko organisaatiossanne jo otettu huomioon näitä vaikutuksia sekä sitä tuleeko asia olemaan tärkeämpi organisaatiossanne tulevaisuudessa.

Tässä osiossa keskitytään IT:n suorien negatiivisten ympäristövaikutusten vähentämiseen ja seuraavissa osioissa keskitytään IT:n epäsuoriin ympäristöhyötyihin. IT:n suorat ympäristövaikutukset ovat niitä negatiivisia ympäristövaikutuksia, joita IT-laitteiden hankinta, käyttö ja käytöstä poisto aiheuttavat. Näihin kuuluu materiaalien käyttö, energiankulutus, päästöt ja jätteet.

10. Onko organisaatiossanne jo pyritty vähentämään oman tai asiakkaidenne IT-investointien suoria ympäristövaikutuksia?

( ) Kyllä
( ) Ei

11. Mihin laitteisiin organisaationne on keskittynyt IT:n suorien ympäristövaikutusten vähentämisessä?

[ ] Palvelimet
[ ] Puhelimet
[ ] Työasemat
[ ] Tulostimet
[ ] Verkkolaitteet
[ ] Muut, mitkä? ____

12. Mihin elinkaaren vaiheisiin organisaationne on keskittynyt IT:n suorien ympäristövaikutusten vähentämisessä?

[ ] Hankinta
[ ] Käyttö
[ ] Käytöstä poisto

13. Mistä ympäristövaikutuksista organisaationne on ollut kiinnostunut IT:n suorien ympäristövaikutusten vähentämisessä?

[ ] Energia
[ ] Päästöt
[ ] Materiaalit
[ ] Jätteet
[ ] Ei kiinnostusta
[ ] En osaa sanoa
[ ] Muu, mikä? ____

14. Mistä laitteista olette tulevaisuudessa kiinnostuneita IT:n suorien ympäristövaikutusten vähentämisessä?

[ ] Palvelimet
[ ] Puhelimet
[ ] Työasemat
[ ] Tulostimet
[ ] Verkkolaitteet
[ ] Muut, mitkä? ____

15. Mistä elinkaaren vaiheista olette tulevaisuudessa kiinnostuneita IT:n suorien ympäristövaikutusten vähentämisessä?

[ ] Hankinta
[ ] Käyttö
[ ] Käytöstä poisto
[ ] Ei kiinnostusta
[ ] En osaa sanoa

16. Mistä ympäristövaikutuksista olette kiinnostuneita tulevaisuudessa IT:n suorien ympäristövaikutusten vähentämisessä?

[ ] Energia
[ ] Päästöt
[ ] Materiaalit
[ ] Jätteet
[ ] Ei kiinnostusta
[ ] En osaa sanoa
[ ] Muu, mikä? ____

Digitalisaation avulla voidaan vähentää koko organisaation ympäristövaikutuksia lukemattomilla eri tavoilla. Digitaalisilla teknologioilla esimerkiksi rakennusten tai laitteiden energiankulutusta voidaan optimoida, mahdollistamalla etätyöskentelyn voidaan vähentää liikenteen päästöjä, prosesseja sähköistämällä voidaan vähentää paperin kulutusta ja paremmalla toimitusketjun seurannalla vähentää hävikin määrää.

17. Onko organisaatiossanne hyödynnetty seuraavia ratkaisuja ympäristövaikutusten vähentämisessä?

[ ] Etätyö
[ ] Sähköiset prosessit
[ ] Energiankulutuksen optimointi
[ ] Toimitusketjun hallinta
[ ] Ei tehtyjä toimenpiteitä
[ ] En osaa sanoa
[ ] Muu, mikä? ____

18. Oletteko tulevaisuudessa kiinnostuneista hyödyntämään tai kehittämään seuraavia ratkaisuja ympäristövaikutusten vähentämisessä?

[ ] Etätyö
[ ] Sähköiset prosessit
[ ] Energiankulutuksen optimointi
[ ] Toimitusketjun hallinta
[ ] Ei kiinnostusta
[ ] En osaa sanoa
[ ] Muu, mikä? ____

19. Mitä organisaation ympäristövaikutuksia olette pyrkineet vähentämään digitaalisilla ratkaisuilla?

[ ] Energia (sähkö, lämpö ja liikenteen polttoaineet)
[ ] Päästöt
[ ] Materiaalit
[ ] Jätteet
[ ] Ei tehtyjä toimenpiteitä
[ ] En osaa sanoa
[ ] Muu, mikä? ____

20. Mitä organisaation ympäristövaikutuksia olette tulevaisuudessa kiinnostuneet vähentämään digitaalisilla ratkaisuilla?

[ ] Energia (sähkö, lämpö ja liikenteen polttoaineet)
[ ] Päästöt
[ ] Materiaalit
[ ] Jätteet
[ ] Ei kiinnostusta
[ ] En osaa sanoa
[ ] Muu, mikä? ____

Digitalisaatio mahdollistaa kokonaan uusia toimintatapoja organisaatioiden, toimitusketjujen, tuotteiden elinkaaren ja koko yhteiskunnan kannalta. Ostokset ja viranomaisasiat voidaan hoitaa yhä enenevässä määrin verkossa, työskentely tapahtuu virtuaalitiimeissä vähentäen tilantarvetta, itseohjautuvat autot ja nelikopterit mullistavat logistiikan. Kyseiset muutokset koskettavat kaikkia toimialoja.

21. Oletteko pyrkineet laajempaan oman liiketoimintanne tai koko arvoketjun (toimittajat ja asiakkaat) toimintatapojen muutokseen digitalisaatiolla?

( ) Kyllä
( ) Ei

22. Oletteko digitalisaation mahdollistamassa muutoksessa ottaneet ympäristövaikutukset huomioon?

( ) Kyllä
( ) Ei

23. Mitä organisaation tai koko arvoketjun (toimittajat ja asiakkaat) ympäristövaikutuksia olette pyrkineet vähentämään digitalisaation mahdollistamilla rakenteellisilla muutoksilla?

[ ] Energia (sähkö, lämpö ja liikenteen polttoaineet)
[ ] Päästöt
[ ] Materiaalit
[ ] Jätteet
[ ] Muu, mikä? ____

24. Mitä organisaation tai koko arvoketjun (toimittajat ja asiakkaat) ympäristövaikutuksia olette tulevaisuudessa

kiinnostuneita vähentämään digitalisaation mahdollistamilla rakenteellisilla muutoksilla?

[ ] Energia (sähkö, lämpö ja liikenteen polttoaineet)
[ ] Päästöt
[ ] Materiaalit
[ ] Jätteet
[ ] Ei kiinnostusta
[ ] En osaa sanoa
[ ] Muu, mikä? ____

25. Mikä motivoi organisaation tai koko arvoketjun (toimittajat ja asiakkaat) ympäristövaikutusten vähentämiseen?

5 kuvaa arvoa erittäin paljon ja 1 kuvaa arvoa erittäin vähän.

5 4 3 2 1 En osaa sanoa
( ) ( ) ( ) ( ) ( ) ( )

Kustannussäästöt
Omat sitoumukset
Asiakkaiden odotukset
Lainsäädäntö
Maine
Uuden liiketoiminnan kehittäminen
Organisaation arvot tai strategia
Riskienhallinta
Yhteiskunnallinen paine (esim. media tai kansalaisjärjestöt)
Kilpailijoiden vastaavat toimet
Erottautuminen kilpailijoista
Ympäristöparannukset osana muuta muutosta