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Designing guidelines for responsible and environmentally sustainable ICT supplier selection

Increasing green ICT awareness in the case organization

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ABSTRACT:
ICT is seen as both a solution and a cause for environmental challenges. When ICT reduces emissions from other sectors, the sector's own emissions and carbon footprint will increase. A significant proportion of the sector's emissions come from ICT equipment, representing 47-54% of total greenhouse gases in the ICT sector. The responsibility of these emissions lies not only with the manufacturers of the equipment, but also with the organizations representing their large group of users. The identification of the adverse impacts of ICT has led to increased demands for organizations to act responsibly and in an environmentally sustainable manner, and to adopt green ICT levers. Efforts have been made to promote ICT's environmental sustainability through changes in sourcing and supplier selection criteria. It is estimated that by 2026, 70% of technology sourcing leaders will have performance objectives aligned to environmental sustainability and 75% of the organizations will increase business with ICT suppliers that provide sustainability targets and timelines.

The study aims to design guidelines for responsible and environmentally sustainable ICT equipment supplier selection. The study is conducted for a case organization that represents an ICT support organization of a Finnish engineering company. The study problem arises from the case organization's need to increase awareness of the adverse environmental impacts of ICT and understand their role in decreasing them. Two research questions have been set for the study: what are the aspects that should be considered in supplier selection to promote environmental sustainability and reduce the environmental burden associated with the sourced ICT equipment, and how does incorporating environmental sustainability in the supplier selection contribute to sustainability efforts in the case organization.

The study is an action design research. To answer the research questions, the first step is to establish a theoretical basis for the topic, after which the empirical part of the study is carried out through workshops. A total of three workshops are held during the design development process, in which the researcher works together and collects input from the professionals from the case organization to design the guidelines to adopt greener supplier selection practices.

As a result of the study, the case organization has guidelines to promote responsible and environmentally sustainable ICT equipment supplier selection. The guidelines support the case organization's journey towards greener ICT operation, the implementation of an environmental perspective into sourcing processes, cooperation with environmentally responsible suppliers, the selection of environmentally friendly equipment, and adoption of circular economy principles. Further research is proposed to implement and test the guidelines and to continue the development of green ICT adoption in other areas of ICT.

KEYWORDS: Green ICT, ICT equipment, environmental sustainability, circular economy, sustainable sourcing, supplier selection, responsible business conduct

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TIIVISTELMÄ:
Tieto-ja viestintätekniikka (ICT) nähdään sekä ratkaisuna että ympäristöhaasteiden aiheuttajana. ICT:n vähentäessä muiden alojen päästöjä, alan omat päästöt ja hiilijalanjälki kasvavat. Merkittävä osa alan päästöistä on peräisin ICT-laitteista, joiden osuus on 47-54 prosenttia koko ICT-alan kasvihuonekaasujen kokonaismäärästä. Päästöt ovat paitsi laitteiden valmistajien vastuulla, myös niiden suurta käyttäjäjoukkoa edustavien organisaatioiden vastuulla. ICT:n haitallisten vaikutusten tunnistaminen on johtanut siihen, että organisaatioita vaaditaan entistä enemmän toimimaan vastuullisesti ja ympäristön kannalta kestävällä tavalla sekä omaksumaan keinoja vihreän ICT:n toteuttamiseksi. ICT:n ympäristökestävyyttä on pyritty edistämään hankinnan muutoksilla ja toimittajan valintakriteereiden avulla. On arvioitu, että vuoteen 2026 mennessä 70 prosentilla teknologiahankinnan johtajista on tulostavoitteet linjassa ympäristön kestävän kehityksen tavoitteiden kanssa ja 75 prosentilla organisaatioista on enemmän liiketoimintaa ICT-toimittajien kanssa, jotka pystyvät esittämään todistetusti kestävyystavoitteita ja aikatauluja.

Tutkimuksen tavoitteena on suunnitella suuntaviivat vastuulliselle ja ympäristön kannalta kestävälle ICT-laitteiden toimittajavalinnalle. Tutkimus tehdään kohdeorganisaatiolle, joka edustaa suomalaisen konepajayrityksen ICT-tukiorganisaatiota. Tutkimusongelma syntyy tapausorganisaation tarpeesta lisätä tietoisuutta ICT:n haitallisista ympäristövaikutuksista ja ymmärtää heidän roolinsa niiden vähentämisessä. Tutkimukselle on asetettu kaksi tutkimuskysymystä: mitkä ovat näkökohdat, jotka olisi otettava huomioon toimittajavalinnoissa ympäristökestävyyden edistämiseksi ja hankittujen ICT-laitteiden ympäristökuorman vähentämiseksi, ja miten ympäristökestävyyden sisällyttäminen toimittajavalintaan edistää kestävyyspyrkimyksiä tapausorganisaatiossa.

Tutkimus on toiminnan suunnittelututkimus. Tutkimuskysymyksiin vastaamiseksi ensimmäinen vaihe on teoreettisen perustan luominen aiheelle, jonka jälkeen tutkimuksen empiirinen osa toteutetaan työpajojen kautta. Suunnitteluprosessin aikana järjestetään yhteensä kolme työpajaa, joissa tutkija yhdessä kohdeorganisaation ammattilaisten kanssa suunnittelee ja kehittää suuntaviivoja vihreämpään toimittajavalintaan.

Tutkimuksen tuloksena kohdeorganisaatiolla on suuntaviivat vastuullisen ja ympäristön kannalta kestävän ICT-laitteiden toimittajavalinnan toteuttamiseksi. Suuntaviivat tukevat kohdeorganisaation siirtymää kohti vihreämpää ICT-toimintaa, ympäristönäkökulman sisällyttämistä hankintaprosesseihin, ohjaavat yhteistyöhön ympäristövastuullisesti toimivien toimittajien kanssa, ympäristöystävällisten laitteiden valintaa ja kiertotalouden periaatteiden omaksumista. Jatkotutkimukseksi ehdotetaan suuntaviivojen implementointia ja testausta, sekä green ICT:n omaksumista muilla ICT:n osa-alueilla.

AVAINSANAT: Vihreä ICT, ICT-laite, ympäristökestävyys, kiertotalous, kestävä hankinta, toimittajavalinta, vastuullinen liiketoiminta

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Abbreviations

ADR	**Action Design Research**
BIE	**Building, Intervention, and Evaluation**
EU	**European Union**
GHG	**Greenhouse Gas**
GPP	**Green Public Procurement**
ICT	**Information and Communication technology**
IT	**Information Technology**
ITU	**International Telecommunication Union**
IS	**Information Systems**

1 Introduction

There is a growing consensus in society and the scientific community that information and communication technology (ICT) is both the solution and the cause of environmental challenges such as GHG emissions and waste (Hankel & Lago, 2016; Latif et al., 2023; Shobande & Ogbeifun, 2022; Welz & Stuermer, 2020). Four major phenomena, integrated with each other, can be seen to have been realized in the past: ICT is more efficient than before, but its global carbon footprint is significant, and secondly, more efficient ICT has enabled the global economy to develop, but this has been overshadowed by a rise in global emissions (Freitag et al., 2021). Putting this pattern together, emissions from traditional industry may be gradually decreasing, but in ICT they are starting to increase (Hion, 2024). As per recent research studies, the ICT sector is estimated to be responsible for between 1.5% to 4% of global greenhouse gas (GHG) emissions (Bieser et al., 2023; Freitag et al., 2020). Yet less attention is paid to ICT as a cause of these challenges (Latif et al., 2023) because the identified potential of ICT to reduce environmental burden in other sectors justifies turning a blind eye to these problems (Freitag et al., 2021). In the organizational context, there is a lack of awareness of the carbon footprint of ICT and significant differences in awareness levels between sectors (Capgemini Research Institute, 2021). Talking about the carbon emissions of digitalization should be more open, users and producers of digital services and products would be more aware of the issue (Hion, 2024).

One of the most significant climate and environmental challenges in the ICT sector is related to end-user devices which are responsible for 47-54% of total GHG emissions in the sector (Allianz Research, 2023; Bieser et al., 2023). End-user equipment is seen as one of the largest sources of GHG emissions of enterprise technology (McKinsey & Company, 2022). Emissions are caused during the extraction of non-renewable materials, energy used in the manufacturing process and use phase, and disposal of physical products (Khor et al., 2015). The most GHG emissions from ICT equipment are released in the production and use phase (Bieser et al., 2023; Felice et al, 2021).

The adverse impacts of ICT have not been ignored, as the issue is increasingly attracting the attention of researchers and practitioners (Santarius & Wagner, 2023). Many international actors are also emphasizing and guiding organizations toward the desired goal: sustainable digital transformation (European Union, 2022; Ministry of Transport and Communications, 2020). For example, the Finnish state among others has committed to the Paris climate agreement by aiming for carbon neutrality by 2030 which requires significant changes in business practices (Hion, 2024). New directives on corporate environmental liability are constantly being proposed, such as the European Commission's proposal for a due diligence directive. The directive obliges companies, their subsidiaries, and business partners to reduce the risks of operations, products, and services that have an adverse impact on the conduct of responsible business (Council of the European Union, 2023). To achieve this, either direct action, preventive action, or leverage is required to influence the factor causing the adverse impact (Organization for Economic Co-operation and Development, 2018). It is socially visible that corporations and organizations are expected to contribute positively to the environment and build a strong, sustainable society (Chou et al., 2023). Integrating sustainable concepts into the business models is required from organizations to become sustainable and change from the traditional economic business model to one that prioritizes social and environmental aspects (Appiah et al., 2023). In terms of ICT, this pressure and responsibility to take environmental aspects into account does not only consider the organizations in the ICT sector, but the responsibility is also shared with the organizations that represent massive groups of users of ICT products and services (Radu, 2016).

Supplier management and sourcing are considered one of the green ICT levers to foster environmental sustainability in information technology (IT) (SustainableIT.org, 2023). In an organizational context, improved sourcing policies and implementing environmental aspects into supplier and product selection are considered effective defense measures for reducing ICT device-related environmental challenges (McKinsey & Company, 2022; Welz & Stuermer, 2020). From an organization's IT function perspective, supplier management and establishing sustainability requirements for the suppliers is a recognized example of sustainable operations and lever of environmentally sustainable IT, and thus adopting green ICT means (SustainableIT.org, 2023). According to Gartner, Inc., by 2026 70% of technology sourcing leaders will have performance objectives aligned to environmental sustainability (Stamford, 2023). Thereby the technology leaders will demand consistent environmental performance from the sourcing functions. In addition, as environmental sustainability has leveraged its position to top 10 business priorities, by 2026 75% of the organizations will increase business with IT suppliers that possess proven sustainability targets and timelines (Stamford, 2023). Traditionally, cost has been the driving factor in supplier selection but due to increased environmental awareness, social responsibility, and legal requirements, criteria that consider suppliers' sustainability performance have been added to the list of factors that affect decision-making (Taherdoost & Brard, 2019). From a public sourcing perspective, studies show that the conscious selection of products and services with low lifecycle emissions, the use of criteria that emphasize lifecycle assessment, energy efficiency, and waste management, is seen to correlate positively with climate change and fostering sustainable development (Singh et al., 2024). Thus, environmental requirements related to sourcing and procedures are seen to encourage suppliers to pay more attention to environmental aspects which thereby enhances their operational efficiency and improves the customer value. To uptake green sourcing means, integration of environmental criteria into supplier selection and decision-making strategy is crucial (Singh et al., 2024). It is acknowledged that by incorporating green ICT operations and culture, organizations can develop their capacity to act responsibly and promote circular economy behavior as their awareness of global environmental challenges such as climate change increases (Appiah et al., 2023).

This study aims to examine the environmental burden associated with ICT equipment and identify key aspects that should be considered when selecting the ICT equipment supplier. The study responds to this need by designing an artifact that consists of guidelines that integrate environmental sustainability into the sourcing of ICT equipment from a supplier selection perspective. In addition, the study considers the contribution of designed guidelines in organization green ICT adoption and environmental sustainability efforts. The study is conducted for an internal ICT service function of a Finnish engineering company. The service function is responsible for developing, managing, and operating ICT services. The service function is referred to as a case organization in this study. The research is important for the case organization because although the entire company that the case organization belongs to is aligned with the objectives and values of sustainable development, there is a gap in the knowledge of what contribution should be made in developing ICT operations in a greener and sustainable direction. For the research community, the study provides fresh insights into the role of ICT function in environmental responsibility and sustainable development. The insights are given by viewing the case organizations' journey in shifting their operations into a greener direction and reducing the environmental impact of ICT devices by taking a conscious approach to responsible and environmentally sustainable ICT supplier selection.

1.1 Research gap

Due to ICT's acknowledged role in reducing other sector's negative environmental effects, it has become a fundamental research issue in the concern of environmental protection. According to Latif and others (2023) in academic research, ICT's impacts on various sectors of society have been successfully noted, but less has been said about the ICT's ecological footprint. Researchers say that digital transition and ICT have a key role in sustainable development and transformation, but on the other hand, substantial investments in digital technologies contribute to growth in energy demand and consumption, and as a rebound effect, digitalized sectors' carbon footprint increases (Allianz Research, 2023; Ferreboeuf, 2019; Latif et al., 2023; Santarius & Wagner, 2023; Zhang et al., 2022). Statistics on the ICT sector's GHG emission indicate that ICT's share of global GHG emissions varied from 1.5% to 4% and it is estimated to increase (Bieser et al., 2023). The issue has been acknowledged and led to an increase in studies on ICT's role in sustainable development, emission reduction, and net zero goal (Belkhir & Elmeligi, 2018; Freitag et al., 2021; Zhang et al., 2022). There are differences of opinion among researchers as to how significant and positive contributor ICT is perceived to be. Some studies point out that ICT is overestimated as a contributor to reducing emissions (Ferreboeuf, 2019; Freitag et al., 2021) while various studies emphasize its potential however by stating that harnessing its potential is not unambiguous and does not necessarily correspond to the expected level (Shobande & Ogbeifun, 2022; Zhang et al., 2022).

In McKinsey's (2022) study, they created an analysis of enterprise technology emissions and pointed out that end-user devices are one of the most significant emissions generators, with three-fourths of emissions coming from manufacturing, transport, and disposal. ICT hardware and electronic equipment are the fastest growing waste stream in the world (Shittu et al., 2021; Tian et al., 2022). In 2020 United Nations E-waste Monitor reported that in 2019 53.6 Mt of e-waste was produced globally and by 2030 the amount is considered to grow up to 74.7 Mt (Adrian et al., 2020). Behind the increasing e-waste according to the United Nations are the growth in consumption rates, short lifecycles, and lack of repair options. To address this challenge, previous research as well as reports from organizations working on the related topic, has shown that changes in an organization's purchasing and usage behavior of ICT have correlations with the reduction of carbon emissions of ICT equipment and in addition the achievement of a company's sustainability goals (Ferreboeuf, 2019; McKinsey & Company, 2022; TIEKE, 2022; Welz & Stuermer, 2020). Both studies and reports by public actors show a consensus that the ICT sector and consumers of ICT products should rely on and promote circularity of the economy and sustainable material flows (Ali & Shirazi, 2023; International Telecommunication Union, 2023; Ministry of Transport and Communications, 2021; Radu, 2016).

The contribution of the organizations to ICT's sustainability has been noted in these studies, as the factors that influence the adoption of green ICT measures in an organizational context have been examined (Hankel et al., 2019; Hu et al., 2016; Radu, 2016). Researchers have also developed models to help organizations assess their sustainability capabilities (Hankel & Lago, 2016), and examined possible incentives and practical actions that organizations can take to increase their sustainability performance (Clifton, 2019; McKinsey & Company, 2022). International organizations and governments have published guidelines for public sustainable sourcing and use of ICT which lean on the ideology of circular economy (Adrian et al., 2020; International Telecommunication Union, 2023; Ministry of Transport and Communications, 2021; World Economic Forum, 2019). However, there is a lack of research on concrete means and sourcing principles that non-ICT organizations or ICT functions can contribute to reducing the environmental burden of ICT, and thus in which contribution level they should have competence to do so. As stated earlier, companies are required to pursue sustainability, environmental responsibility, and carbon neutrality in their operations. The underlying question here is how organizations whose core business ICT is not should contribute to sustainable practices and adopt green principles in their ICT operations. The value of this study is not limited to increasing knowledge of the relationship between ICT equipment and environmental impacts, but also to identifying concrete ways and approaches that can reduce the environmental impact of ICT equipment and thus support the fulfillment of organizations' social responsibility in building a sustainable society.

1.2 Research problem, scope, and objectives

The premise of the relevant business problem arises from the case organization's need to increase awareness of the environmental sustainability of their ICT operations. The strategic core of the Finnish engineering company, which the case organization is part of, is sustainability, and it has a strong passion for driving decarbonization in its market sector and key business areas. Promoting carbon neutrality in their internal business operations is also one of their key targets. However, the detailed decarbonization targets and measures are optimized to the company's core business areas and therefore do not have specified targets for the company's internal ICT operations. The reason behind this is that sustainability in ICT operations is only just waking up, and the company does not have a clear set of measures or guidelines on how to adopt green and sustainable practices in this area.

Currently, in the case organization, there is no clear understanding of the environmental impacts associated with the purchase of ICT equipment. Due to that, there are no clear procedures, guidelines, or list of requirements to support the decision-making or implementation of systematic environmental sustainability considerations to the sourcing and supplier selection of ICT equipment. ICT equipment sourcing in the case organization also considers the services used by the equipment, but these are excluded from this study. The study does not examine the sourcing process as a whole but focuses on the supplier selection phase. Within the limitations of the study, sustainability is considered and applied to the artifact by representing the environmental sustainability levers and aspects. When referring to the ICT equipment in this study, it relates to the end-user equipment.

Two research questions are formulated for the study. The answers to the questions will contribute to a better understanding of the environmental impact of ICT equipment, environmental sustainability in supplier selection, and its relationship to sustainability efforts within the case organization. The research questions are set as follows:

1. What are the aspects that should be considered in supplier selection to promote environmental sustainability and reduce the environmental burden associated with the sourced ICT equipment?
2. How does incorporating environmental sustainability in supplier selection contribute to sustainability efforts in the case organization?

In this study, the problem is approached by using an action design research (ADR) method, first by building a theoretical baseline from the previous research. The theoretical baseline consists of insights into the climate and environmental challenges associated with ICT, circular economy, green ICT and its adoption, maturity, and readiness in organizations, sustainability in sourcing with a specification to supplier selection, and environmental sustainability in ICT sourcing. In the later stages, the study proceeds to design the guidelines in an organizational context with the practitioners. The design development in the context organization considers the continuous design and evaluation of the guidelines through discussions and workshop sessions. Throughout the process, the topic is reflected into practice, and learning outcomes are evaluated.

By answering the research questions, the study aims to establish supportive guidelines for adopting green ICT business practices, consistent consideration of environmental sustainability in ICT supplier selection, building structure for decision making, raising awareness of the most significant aspects of the environmental impact of ICT devices and bring visibility to the link between purchasing decisions and environmental consequences. The study seeks to demonstrate that improved sourcing levers can play a significant role in moving towards environmentally sustainable practices and thus strengthen an organization's maturity around environmental sustainability. The study aims to encourage a broader discussion of green ICT and the contribution level that the non-ICT sector organization's ICT service organization/function should have related to the sustainability of ICT. The results of this research aim to raise the recognition that the environmental sustainability of ICT is not only the responsibility of the ICT sector organizations. The organizations that purchase ICT equipment are as much responsible for reducing the adverse impacts of ICT and shifting their business operations toward an environmentally sustainable direction, as their efforts to do so are seen as relevant as others.

1.3 Structure of the research

The study is divided into five main chapters as follows: introduction, literature review, research methodology, design development process and final artifact, and discussion and concluding remarks. The purpose of the first chapter is to introduce the background of the study and present the relevant research problem, scope, and objectives. The objectives of the research are presented through the research questions, and the chosen research method specifies the means to achieve the objectives. To gather a coherent theoretical background for the study, the second chapter brings together previous observations and research findings on the topic under study and identifies their interrelationships. The theoretical approach forms a solid scientific baseline for the study, and it will be applied to the context of the study to support the development of the artifact.

In chapter three, the selected type of study and research method is presented. The research method is a means to answer the research questions set for this study and achieve its objectives. By presenting the research method we ensure the reproducibility of the study. Chapter four continues to present the is the empirical part of the study, presenting the design development process and the final artifact. The process contains the stages of development in the organizational context: workshops, data collection, and analysis. At the end of the chapter, the final artifact is introduced and the collection of the relevant knowledge data, learning outcomes, and the evaluation of the designed artifact is presented. The artifact is evaluated in the context of validity and utility.

The fifth and final chapter summarizes the objectives of the study and presents the main findings based on the analysis of the study results and designed artifact. Discussion and concluding remarks provide a comprehensive overview of the most important findings for the case organization and contributions to practice and theory. In addition, the feasibility of the selected research method to address the research problem and the research questions are assessed. The limitations of the study and suggestions for further research are presented in the end.

2 Theoretical framework

A theoretical framework for this study is created by reviewing the findings from the prior literature and research on the topic under study. The academic and scientific foundations, accessible research articles, and reports for this study are mainly retrieved from the centric databases of information systems science. Public reports and documents from various actors, such as the European Union, the European Commission, and the Finnish Ministry of Transport and Communications are also used while building the framework. In addition, reports of associations and companies focusing on sustainable development and environmental sustainability in ICT have been used.

The perspectives and theoretical implications selected for the study are reasonable in terms of solving the research problem, answering the research questions, and organization needs. To build the framework, the keywords of the study are used in the search engines of the databases. The initial keywords of the study are green ICT, ICT equipment, environmental sustainability, circular economy, supplier selection, and responsible business conduct. The framework consists of components that examine the role of ICT in environmental challenges and sustainable development, the green ICT perspective, sustainable sourcing and supplier selection, and environmental responsibility in ICT sourcing.

2.1 ICT as a solution and contributor to environmental challenges

ICT has been identified as a decisive factor, a solution for reducing the environmental burden and greenhouse gas emissions of other sectors such as energy, transportation, and agriculture (Ferreboeuf, 2019). In this context, digital technology is often associated with the concepts “IT for Green”, and “Greening by IT” are used to describe its nature (Ferreboeuf, 2019). ICT in its nature has the potential to optimize and improve operational efficiency, replace, and reduce physical products, optimize processes, and reduce energy consumption and CO2 emissions of other sectors (McKinsey & Company, 2022;

Ministry of Transport and Communications, 2020; Santarius & Wagner, 2023). The digital transition has made ICT ubiquitous in nature and advanced ICT infrastructure created a widely interconnected society (Ministry of Transport and Communications, 2020). Despite the acknowledged and promising role of ICT in sustainable development, some researchers are more vocal about the adverse role of ICT: it is a contributor to increased negative direct and indirect impacts on the climate and environment such as high energy consumption, greenhouse gas emissions, and electronic waste (e-waste) (Clifton, 2019; Ferreboeuf, 2019; Radu, 2016).

In November 2020 Finnish Ministry of Transport and Communication published its climate and environmental strategy for the ICT sector. The Finnish Ministry was a pioneer in publishing the strategy, as it was the first ICT sector's climate and environment strategy. The report presents the current situation of the climate and environmental impacts of the ICT sector and recommendations for action (Ministry of Transport and Communications, 2021). The implementation of the strategy is based on the objective of a carbon-neutral Finland by 2035 which applies to emission reduction in all sectors. The working group behind the strategy consisted of representatives from the government, organizations, universities, and businesses. In June 2020 they first published an interim report on the strategy (Ministry of Transport and Communications, 2020). The report notes that it is only recently that ICT-related climate and environmental issues have come to the forefront, as so far at the international level ICT sector's impacts on the climate and environment have been mainly focused on the potential of digitalization to deliver emission reductions. The same issues have also been highlighted in research on the matter (Ferreboeuf, 2019; Freitag et al., 2021; Latif et al., 2023).

Prior literature has examined the doable nature of ICT and analyzed the impacts of ICT on the environment and climate by categorizing them according to their nature (Hankel et al., 2018; Hilty & Aebischer, 2015). Typically, the research brings up the effects in three categories: principal, secondary, and tertiary effects (Hilty & Aebischer, 2015; Latif et al., 2023), and some studies broaden the range to five categories, which further define the impact on the organization and society (Hankel et al., 2018). Some studies describe the direct and indirect effects of ICT and the use of digital technologies as “rebound effects” (Ferreboeuf, 2019).

Ferreboeuf (2019) discusses that the concept “rebound effect” was acknowledged already during the Industrial Revolution. The assumption that improving energy efficiency through a particular product or activity would have a downward effect on energy consumption was not as straightforward as thought. Increasing energy efficiency has the opposite effect: increased overall energy consumption. Although the ICT industry has improved the energy efficiency of digital technologies, the negative reflectance effects of the global digital transition could not have been excluded (Ferreboeuf, 2019). Ferreboeuf (2019) points out the overestimation and underestimation related to the use of digital technologies. The use of digital technologies to reduce the environmental burden of other sectors requires massive resources for digital technologies, which often leads to underestimates of direct and indirect impacts. Substantial investments in digital technologies contribute to growth in energy demand and consumption, and as a rebound effect, digitalized sectors' carbon footprint increases (Ferreboeuf, 2019; Latif et al., 2023; Santarius & Wagner, 2023; TIEKE, 2023).

In the report of the Finnish Ministry of Transport and Communications (2020), the positive and adverse impacts of ICT are divided into three high-level impacts. Positive impacts include reduced GHG emissions from other sectors, digital solutions to support environmental and nature conservation, and solutions that facilitate adaptation to climate change. Adverse impacts are related to energy consumption and GHG emissions, raw material used in the infrastructure and the equipment, and emissions to air, water, and soil. SustainableIT.org (2023) presents IT’s environmental sustainability as reflecting the more to the positive effect that IT has brought into IT and by IT for the enterprises and industry/sector. Figure 1 illustrates the levers of each three dimension.

Environmental sustainability *in* IT

- Data Centre & Cloud Computing
- Sustainable Software Development
- Circular IT Hardware
- IT Vendor Management & Procurement
- E-waste

Environmental sustainability *by* IT for the enterprise

- Energy-efficient Buildings
- Energy Resource Management
- Hybrid work
- Eco-friendly Travel & Transportation
- E-services

Environmental sustainability *by* IT for the industry/sector

- Common Process Digitalization
- Standard Sourcing Certifications
- As-a-Service Infrastructure
- Climate Risk Management
- ESG Accounting & Reporting Platform

Figure 1. IT's Environmental Sustainability Levers (SustainableIT.org, 2023).

In 2015 Hilty and Aebischer presented an LES model in which ICT effects on the environment are leveled into three. The term LES comes from the three effects which they have named as follows: lifecycle impact, enabling impact, and structural impact. In the LES model, level one describes the lifecycle impact or in other words the direct effects of ICT. The first level, lifecycle impact, is divided into the production and disposal of ICT and the use of ICT. Environmental impacts related to the production and disposal of ICT are in turn divided into the production of raw materials, production of ICT hardware, recycling of ICT hardware, and final disposal of residues. The environmental impacts of ICT use and hence energy consumption are categorically divided into the impacts of ICT hardware and infrastructure of ICT. The second level, enabling impact, is considered as the indirect impact of ICT and they are viewed from the production and consumption in the model. These indirect impacts can create change in organizational, behavioral, and technological sectors such as process optimization, material substitutions, and externalization of control of processes, and can exist in production and consumption (Hilty & Aebischer, 2015). The final and third level is the structural impact, which can also be described as the socio-economic impact of ICT or systemic effects of ICT. These impacts are correlated with the second-level impacts, whose long-term and static implementation generates structural and institutional changes in society and the economy. Examples of structural changes that Hilty and Aebischer (2015) present are dematerialization and as an institutional change, environmental and climate policies.

After Hilty and Aebischer (2015) presented their LES model, Hankel and others (2018) continued to enhance the understanding of the effects of ICT on the environment by creating a systematic literature review of factors of influence on the environmental impact of ICT. They created a framework for supporting the organizations and practitioners to realize the full potential of green ICT which reflects the leveraging the potential of ICT to foster environmental sustainability. The concept of green ICT will be introduced in chapter 2.2. As a premise, they used Hilty's and Aebischer's (2015) findings to support the classification of the factors into domains. They identified 97 unique factors of influence that are divided into five domains, the last two of which Hankel and others (2018) added to Hilty's and Aebischer's model: direct impacts of ICT, indirect impact of ICT, systemic impact of ICT, societal impact on organizations, and organizational impact on ICT. It is pointed out in the results of the study that the scientific literature should focus on each of these five domains to fully understand the impacts of ICT and put this understanding into practice. In the framework, direct impacts of ICT refer to factors such as production, external interactions, current state, and governance. Factors of indirect impact of ICT are for example teleworking and collaboration, smart energy, and e-commerce, which describe that with the use of ICT, the environmental burden is decreased in other sectors. The systemic impact of ICT factors is adoption and innovation, which present the systematic and long-term use of ICT and thereby the effects afterward. Societal impact on organizations as a domain of factors presents external factors such as compliance, transparency, and environmental risks. Organizational impact on ICT on the other hand consists of factors such as organizational culture, strategy, and current state. These domains together form a cyclical distribution and interconnection, describing causal effects between domains. The cycle and connection between the domains are presented in Figure 2.

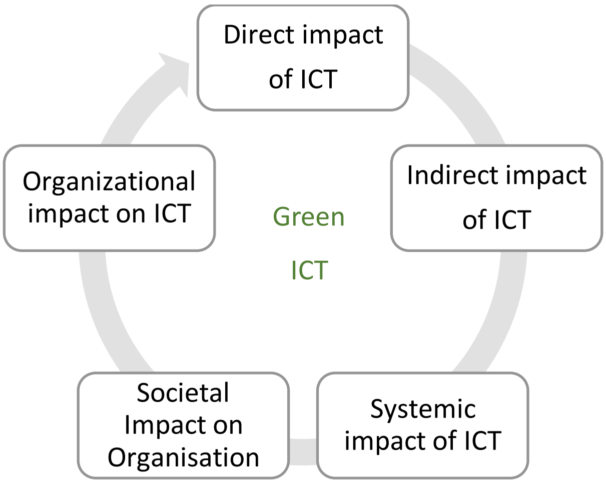

Figure 2. Cyclical description of the connection domains (adapted from Hankel et al., 2018).

2.1.1 The environmental impact of ICT equipment

In simplicity, the ICT hardware product life cycle can be divided into production, use, and end-of-life (Hilty et al., 2008). When widening the view, it can be divided into material acquisition and preprocessing, production, product distribution and storage, use, and end-of-life (GeSI, 2017). These stages consist of the extraction, processing, and manufacturing of the raw materials used in the equipment, after which the equipment is transferred to its user, such as individuals or companies, either for its lifetime or for a contractual period to deliver its intended service, and when the equipment meets its end-of-life, it is reused, recycled or disposed of (Eerola et al., 2021; Hilty et al., 2008; Ministry of Transport and Communications, 2020). It is worth noting that each stage of the life cycle leads directly or indirectly to the use of natural resources and the release of residues into the environment (Hilty et al., 2008). Visualization of the life cycle is presented in Figure 3.

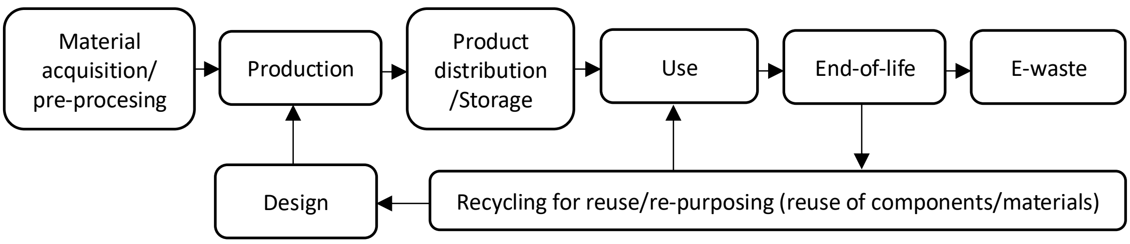

Figure 3. ICT hardware life cycle (adapted from Hilty et al., 2008).

The emissions of ICT can be viewed from Scope 1, Scope 2, and Scope 3 emissions (Freitag et al., 2020). Scope 1 emissions are direct emissions that come from owned or controlled sources, Scope 2 are indirect emissions generated from the purchased electricity, heat, and steam, and Scope 3 are other indirect emissions that come from the activities of the company, but they either occur from other sources or/and are not under company's control (Greenhouse Gas Protocol, 2004). Most of the companies are focusing on Scope 1 and Scope 2 emissions, even the Scope 3 emissions represent the largest amount of GHG emission inventory of companies (Farsan et al., 2018). Most of the Scope 3 emissions come from purchased services and goods, which constitute of large part of the organization's ICT carbon footprint (Freitag et al., 2020; Global Supply Chain Report, 2018).

Global Supply Chain Report (2018) collected data from 4800 companies and it came up that 56% of the respondents discloses their scope 1 emissions, 62% scope 2 emissions, and only 34% scope 3 emissions. Scope 3 emissions are a challenging dimension, as the companies are not able to fully control them and they overlap with other companies' emissions (Farsan et al., 2018). Farsan and others (2018) present that companies use this as a reason not to contribute to reducing their Scope 3 emissions as there seems to be only a line drawn in the water about the responsibility of removing emissions between the companies. However, companies that reduce their Scope 3 emissions can benefit from the outcomes (Farsan et al., 2018). Farsan and others (2018) point out that a better understanding of the value chain can give opportunities for collaborative innovation with the suppliers, to respond to various stakeholders' requirements to decrease operational impacts to the climate and environment and both proactive accounting. Considering the Scope 3 emission also reflects on taking responsibility for their value chain emissions (Freitag et al., 2020). Management of Scope 3 emissions is important to evaluate the risks of the value chain such as the changes in the regulations and tightening product efficiency standards (Farsan et al., 2018).

Prior studies that have conducted studies on the lifecycle analysis of ICT indicate that the lifecycle phases that have the biggest environmental impact are production and use (Arushanya et al., 2014; Alfieri et al., 2021; Bieser et al., 2023; Felice et al, 2021). The dominance of these phases varies depending on the product, but in most ICT goods and services the use phase has the highest environmental impact and total emissions due to the amount of energy consumed during use (Arushanya et al., 2014; GeSI, 2017). Also, TIEKE (2022) who carried out a societal project on green ICT argues that the most significant sustainability challenge for equipment relates to the use phase of the equipment's life cycle due to for example shortened replacement times and software requirements. Highly energy-efficient products, on the other hand, tend to have a greater environmental impact during the production phase (Arushanya et al., 2014). The high amount of GHG emissions released during the production phase are justified by the GHG intensity of the phase and a growing number of the devices (Bieser et al., 2023).

Even though the manufacturing and use phases are the most significant in terms of environmental impact, all the phases of the ICT equipment lifecycle have sustainability challenges (Eerola et al., 2021). For example, in Capgemini Research Institute's (2021) report on sustainable IT, in addition to the production stage, the disposal of IT devices is linked to significant environmental impacts. GHG emissions are released throughout each phase starting from the extraction of raw materials, manufacturing process, energy used for the operational phase, and disposal (Belkhir & Elmeligi, 2018; Khor et al., 2015). Raw material procurement challenges relate to growing material needs and the use of rare and non-renewable materials as the amount of ICT equipment is growing constantly (Eerola et al., 2021). The design and manufacturing phase is challenged from the view of sustainability as there are high expectations of functionality but the requirement for efficiency can increase adverse impacts on the environment and working conditions vary (Eerola et al., 2021). The use phase and the length of useful life are challenged by the increased customer expectations, lack of transparency on the recyclability of the product (Eerola et al., 2021), increased software hardware requirements, reduced performance of the device, and end-of-support for legacy systems and equipment which leads to faster equipment replacement and shortening of the use phase (TIEKE, 2022).

End-of-life phase challenges are on the other hand related to low collection and recycling rates, and challenges in recycling complex materials used in products (Eerola et al., 2021). Each product has a specific lifetime, as typically electrical and electronic equipment are designed to perform for a certain period (Shittu et al., 2021). After that time, the equipment stops working or performs less than optimally. When the equipment reaches its end-of-life phase, and if it is decided to be discarded, it becomes electronic waste (e-waste). The increase in the production and use of ICT equipment makes this type of waste grow rapidly (Hilty, 2008) and e-waste has become one of the biggest waste streams in the world (Tian et al., 2022). Some of the substances in e-waste are harmful to both human well-being and the environment (Capgemini Research Institute, 2021). Typically, disposal of ICT equipment in enterprises is either done via collecting/recycling, keeping in the enterprise (as spare parts or to prevent sensitive being exposed), or sold, returned to the leasing enterprise, or donated (Eurostat, 2023). In 2022, 28.3% of EU enterprises reported that when the ICT equipment is not used anymore, they either sell, return it to a leasing enterprise, or donate it (Eurostat, 2023).

2.1.2 Mitigating effects of circular economy on the adverse impacts of ICT

At the heart of the circular economy is the idea of eliminating waste and designing products for reuse (Ellen MacArthur Foundation, 2013). It replaces the concept of end-of-life with one that promotes the use of renewable energy, eliminates toxic chemicals, increases reuse, and seeks to reduce waste through better design of products, materials, systems, and business models. Kirchherr and others (2017) describe the circular economy as a way to achieve sustainable development while simultaneously increasing environmental quality, economic prosperity, and social justice. Similarly, Appiah and others (2023) illustrate that circular economy advocates seek to change the way economic growth is conceived and promote a gradual exit from the finite consumption of resources and the total removal of waste from the system. The European Commission (2015) defines that the circular economy principle seeks to maintain the value of products and materials as long as possible and minimize the waste and resources, the resources stay in the economy to generate further value when they reach the end-of-life phase. From the definition can be seen the alignment with the core philosophy of the circular economy and emphasizes the recognition of the value derived from the longevity of products and materials.

Circular economy principles and actions are believed to have a positive impact on the most significant environmental challenges of the ICT life cycle in terms of emissions, overconsumption of materials, and waste generation (World Economic Forum, 2019). When companies consider their circular economy approach and aim for a closed loop, they can extend the product's useful life, decrease the material demand, and reduce waste (Farsan et al., 2018). Shittu and others (2021) highlight that to manage the increasing amount of e-waste, it is necessary to adopt circular economy practices. According to Appiah and others (2023), the implementation of circular economy behavior is positively affected if the corporation possesses a green corporate culture.

The Circular Economics Partner (2022) argues that a circular approach to electronic equipment can help address the effects of ICT and the challenges that ICT poses to the environment, society, and the economy. Circular IT hardware is considered one of the environmental sustainability levers in IT (SustainableIT.org, 2023). By designing, manufacturing, using, and recycling products and the materials used to make them so that they remain in circulation, we can have a positive impact on carbon emissions and reduce the amount of electronic waste going to landfills (Circular Economics Partner, 2022). Part is the consideration of the end-of-life treatment and recyclability of the product already in the design phase (Löw et al., 2021). The Circular Economics Partner (2022) created a viewpoint for circularity by presenting three attributes, circular resources, circular design, and actual recovery, that together define a circular electronic product. The first attribute, circular resources, reflects the secondary and renewable resources/inputs used in the product. The view underlies that the more reused components and parts are used when making the product, the more circular the product is as there is a decrease in the processing of new and extracted materials. The second attribute, circular design, considers the product design from the aspects of durability, repairability, upgradability, resource efficiency, and recoverability. These aspects describe the approach keeping in mind that when designing a product, the product should be use-phase optimized and in addition, the materials should be recoverable. The third and final attribute, actual recovery, refers to the optimization of the usage phase and end-of-life activities. An example of optimizing the use of the product is the continuous management and maintenance of the product condition with monitoring tools and repair services (The Circular Economics Partner, 2022). These implications to product design can bring benefits such as ease in end-of-life treatment and insurance of higher quality material that can be used as a material for secondary products (Löw et al., 2021).

2.2 Green ICT

Scientific research on ICT's climate and environmental impacts has resulted a term, green ICT, to describe ICT-enabled sustainable development and green ICT itself. IT, information systems (IS), and ICT together form an overlapping and correlated whole, when considered from the sustainability and environmental impact perspectives of ICT. Khor and others (2015, p. 572) describe this interconnection between green ICT, IS, and IT as follows: *"Green information technology (IT) is a critical domain of green information systems (IS) as utilization of environmentally sustainable information and communication technologies (ICTs) facilitates informed decision-making."* For the term green ICT to be understood, and to have a solid basis, it needs to be considered holistically by reviewing the terms green IS and green IT. In Table 1 selected definitions from prior studies for green IT, IS and ICT are presented.

Table 1. Definitions of green IT, IS and ICT from prior literature.

Author	Definition	Term
Ning and Khuntia (2023)	*"Green information technology (green IS) is the discipline, area or focus of information systems (IS) for environmental sustainability"*	Green IS
Singh and Sahu (2020)	*"It is the effective and efficient IT/S expertise and set of practices focused on plummeting GHGs emissions, carbon footprints and ensuing environment sustainability in the society."*	Green IS
Chou and others (2023)	*"Green IT is a movement in the IT industry for fulfilling the goal of environmental sustainability. The realization of green IT can benefit the society by diminishing the concern in environmental protection."*	Green IT
Molla (2009)	*"Green IT is an organization's ability to systematically apply environmental sustainability criteria (such as pollution prevention, product stewardship, use of clean technologies) to the design, production, sourcing, use and disposal of the IT technical infrastructure as well as within the human and managerial components of the IT infrastructure."*	Green IT
Helali (2020)	*"Green IT, or Eco-ICT, or informatique verte in French, is a concept defined as all information and communications technologies designed so that their economic, ecological and social footprints are optimized."*	Green IT, Green ICT
Radu (2016)	*"In the case of ICT, environment protection involves the development of hardware and software with minimal influence on the environment (radical innovation) or improving the existing ones (incremental innovation), and using ICT for diagnosing and solving environmental problems."*	Green ICT
Deloitte (2023)	*"More than just a trend, green ICT is a critical practice focused on minimizing environmental impact through efficient energy use, lower carbon emissions, and waste reduction in the ICT domain. It can help promote sustainability while at the same time improving efficiency, reducing costs, and ensuring companies remain competitive in a rapidly evolving technological landscape."*	Green ICT

Ning and Khuntia (2023) describe green IS as a discipline or focus area that aims for environmentally sustainable development. They continue to present that in the organizational context, green IS can support decision-making from the sustainable perspective, reduce the environmental impact of their operations, and commit to the regulative requirements, in addition, green IS enables innovative growth and positive reputational development. Singh and Sahu (2020) describe green IS as an efficient and effective activity based on IT/IS expertise and practices, focusing on reducing greenhouse gas emissions and carbon footprint, further contributing to building a sustainable society.

Chou and others (2023) present the concept of green IT referring more to the responsibility of the IT manufacturing companies by highlighting green IT as a movement of the IT industry, to achieve the goals related to environmental sustainability. Helali (2020) extends the definition to the three pillars of sustainability, economic, ecological, and social, and refers to their consideration in the design phase of IT and ICT technologies. Molla (2009) widespread the concept by presenting a definition of green IT that considers the dual impact of IT from a holistic perspective and includes not only the technology but also the soft way of doing business. The definition reflects firstly the reach of green IT, the extent to which a company systematically takes environmental consideration into account from a lifecycle perspective, and secondly the richness of green IT, the level of the company's maturity to take the environment into account in their daily operations and appliance into their systems and technologies (Molla, 2009). Ning and Khuntia (2023) align with this view by suggesting that green IS can be considered more from an operant perspective as it requires active management at all levels of the organization, proactive data collection on the impact of operations in different areas, developed skills to assess the data about the current situation from a sustainable perspective and thus define areas and targets for development.

According to Radu (2016) when talking about ICT-enabled actions to protect the environment and solve environmental problems, it includes the development of new hardware and software or the improvement of existing ones in such a way that they cause the lowest possible environmental impact, and the use of ICT to monitor, analyze, and solve environmental problems. Green ICT as a concept is typically associated with technologies that are specifically oriented to reduce environmental damage that are outcomes of the usage of ICT (Radu, 2016). This definition considers the dual role of ICT as a solution and a cause of sustainability challenges but focuses on technology itself. To this Deloitte (2023) brings a slightly expanding perspective on that green ICT is a practice that focuses on minimizing the environmental impact through energy-efficiency, low carbon emission, and waste reduction. As a practice, it can generate positive effects related to sustainability as well as improve efficiency, reduce cost, and ensure companies' competitiveness.

To apply the term green ICT to the context of the study, a working definition is created and used for the occasion of this study. It is necessary to create a term from which a relation to the activities and responsibilities of the case organization can be seen. The premise of the definition comes from the selected and presented definitions in Table 1 and is formulated by using Aristotle's method (Smith, 2022). To refine the term in the context of this study the definition is increasingly directed to describe the responsibility of ICT function of their environmental sustainability and the means to reduce the environmental burden of their operations, services, and equipment. Green ICT in the context of this study describes the organization's consciousness, capabilities, and levers to take environmental sustainability into account in its development, management, and operations of ICT. Green ICT refers to the ability to set systematic criteria, environmentally sensitive decision-making, and cultural behaviors that guide the development of ICT operations toward the total elimination or minimization of the adverse environmental impacts of ICT throughout its lifecycle.

2.2.1 Drivers and motivations

Concerns arising from global challenges and increased awareness of the importance of the ecosystem, organizations have encountered pressures to change their perspectives and contribute to reducing environmental pressures while ensuring business continuity and growth (McKinsey & Company, 2022; Molla, 2009; Radu, 2016; Fok et al., 2022). Already in 2009, Molla pointed out that companies have recognized the impact of their activities on the environment and their responsibility around environmental protection and reduction of the footprint. However, McKinsey and Company (2022) point out that there is a lack of understanding of clear opportunities for environmental actions within organizations and managers working with technology as they do not have the necessary and needed knowledge. In 2019 Capgemini Research Institute surveyed 1000 organizations to understand how to make the IT within the enterprises more sustainable. The results indicate that globally only 43% of the organizations' executives are aware of their IT footprint. Between the sectors, there are fair differences in the level of awareness e.g. in the banking and consumer products sectors the awareness level is relatively higher (52%) than in the industrial manufacturing sectors (28%). The results also reveal that only 18% of the organizations have sustainable IT strategy. It reflects that sustainable IT is disconnected from the enterprise-wide sustainability strategy, which 50% of the organizations have (Capgemini Research Institute, 2021). Organizations' different abilities, levels of awareness and willingness to adapt, implement, and develop green ICT varies (McKinsey, 2022), which has sparked interest in the research community to explore the underlying drivers and motivations behind the adoption of green ICT (Hankel et al., 2019; Molla et al., 2008; Molla, 2009).

In 2009, Molla studied the underlying organizational motivations for adopting green IT. The study points out the key difference between the adoption of IT and green IT: adoption of IT is influenced by its short-term potential and tangible economic benefits it may bring, while the adoption of green IT is influenced by background knowledge of the state of the environment and its potential to reach green targets. Organizational motivations for greening IT Molla (2009) divides into four factors: eco-effectiveness, eco-responsiveness, eco-legitimacy, and eco-responsive which together form a Green IT Motivation Grid (Table 2.). Later Radu (2016) studied the determinants impacting green ICT adoption in organizations and divided them into three categories: economic, ethical, and regulatory. According to Molla (2009), eco-effectiveness refers to the corporation's strategy, attention to the environment, and social acceptance, to which Radu (2016) describes and adds the ethical determinants that include social responsibility and awareness of the state of the environment. Eco-efficiency on the other hand refers to the cost of greening IT and reducing the cost of IT according to Molla (2009) into which Radu (2016) emphasizes the economic determinants that consider company characteristics, knowledge, and technology capabilities, and cost saving. Eco-responsiveness as a factor refers to the actions of competitors and pressure from both, IT vendors and customers (Molla, 2009) to which also Radu (2016) is in line that competitive setup is one of the economic drivers. Eco-legitimacy refers to government incentives, and the widespread of green IT and industry associations (Molla, 2009) in which Radu (2016) adds the regulatory determinants that include initiatives from non-governmental institutions, environmental grants, internal and external policies, and legal regulations. According to Molla (2009) two of these factors, eco-efficiency, and eco-effectiveness, seem to have a higher impact as a motivational factor regarding green IT adoption and are seen as a factor coming from within the organization.

Table 2. Green IT Motivation Grid (adapted from Molla, 2009).

Factors	**Focus of Motivation**	**Locus of Motivation**
Eco-efficiency	Economic	Internal
Eco-effectiveness	Regulatory/Normative	Internal
Eco-responsive	Economic	External
Eco-legitimacy	Regulatory/Normative	External

2.2.2 Maturity and readiness

According to SustainableIT.org (2023), IT leaders have three sustainability tiers: IT function, enterprise, and industry/sector. The levels scale in terms of their consequences, reflecting the fact that as moving from the function level to the industry level, environmental impacts such as emissions at different levels increase. At each level, there are potential ways to influence the sustainability of IT (Table 3.). At the function level, the means are related to cloud infrastructure, energy-efficient hardware and software coding, automation, circular end-user devices, data center energy consumption, and vendor requirements. Enterprise level on the other hand considers means such as service infrastructure, automated processes, paperless operations, hybrid workforce and meetings, accounting, reporting, decision-making, and risk management in terms of sustainability. The industry and sector level thereby consist of means such as common processes, certified technology sourcing, circular principles, service infrastructure, and shared responsibility (accounting and reporting) on climate risk management.

Table 3. Sustainability tiers and description (adopted from SustainableIT.org, 2023).

Sustainability tier	**Description**
IT function	As a function, IT exemplifies sustainable design and operations by shifting to cloud-hosted infrastructure, uses energy-efficient hardware and software coding, automates IT services, establishes a circular lifecycle for end-user devices, optimizes data center energy consumption, and establishes vendor sustainability requirements.
Enterprise	As IT drives digital business transformation, it virtualizes services infrastructure (Everything-as-a-Service), automates emission-intensive business processes, enables paperless operations, supports an optimal hybrid workforce model, and reduces need to travel through virtual meeting support. As principal data managers, IT facilitates sustainability accounting, reporting and decision-making, and enterprise risk management.
Industry/sector	IT cooperation within and across industries will scale digitization of common operating processes, certified technology sourcing and circular lifecycle management, pervasive as-a-service infrastructure, best-practice climate risk management; and standardized sustainability accounting and reporting facilitated by a common platform.

Molla and others (2008) argue that there are at least five drivers in the organizations that make them successful in greening IT and having preparedness being environmentally conscious and in addition, competitive. It is acknowledged, that to obtain a competitive position in the rapidly changing market environment, organizations need to adapt quickly (Deloitte, 2023). The competitiveness of the organization comes when creating variations of drivers and succeeding in terms of being environmentally responsible (Molla et al., 2008). These five drivers that Molla and others (2008) present, form components of the G-readiness framework through which the organizational maturity in sustainability of IT can be evaluated. These drivers are attitude, policy, practice, technology, and governance. In 2019 Hankel and others studied three organizations' green ICT adaptation to understand what needs there are to adopt green ICT and used Molla's G-readiness framework as a perspective to the results. In Molla's frameworks (2008), attitude as a driver reflects the IT and business awareness of economic, strategic, regulatory, environmental, and social concerns. Policy driver measures the extent to which sustainable policies have been applied in the organization and its value chain starting from IT sourcing, operations, services, and end-of-life management. Practice thereby measures the extent to which organizational concerns and policies are translated into concrete actions such as in IT sourcing or end-of-life management. Technology as a driver reflects green technological infrastructure such as data center energy optimization or green power sources. Finally, governance is a driver that measures and reflects the management premise for green IT development. By reflecting on the results of the study of these drivers Hankel and others (2019) conclude five most important factors that affect the adoption of green ICT. The first observation relates to the lack of consistency in strategic orientations at all levels, which hinders adoption of green ICT. The second is that the adaption needs leadership that supports bottom-up enthusiasm and action towards sustainable development. Third, there needs to be a cultural and attitudinal shift towards an acknowledgment of the sustainable value of ICT. The fourth finding relates to ICT governance, which requires shared responsibility and action to reduce knowledge and communication gaps. The fifth finding relates to the fact that the strength of the technology infrastructure is not a bottleneck to the adoption of green ICT.

Molla (2009) continued the study to examine the organization's green IT readiness and proposes that readiness can be divided into two dimensions: reach and richness (Table 4). This forms a Green IT Reach-Richness matrix, in which the green IT reach dimension is categorized into three areas sourcing, operations, and end-of-IT life management, and the green IT rich dimension is divided into policies, practices, and technologies and systems. The reach reflects the extent to which the organization takes environmental consideration into account in its technology sourcing, operations, and end-of-life management. Richness on the other hand reflects an organization's consistent approach to sustainability, the integration of green into operational practices, information systems, and technologies (Molla, 2009). In Deloitte's Green ICT survey in 2023, they surveyed banking sector institutions in terms of green ICT maturity and ICT CO2 emission. They created a framework for the survey which consists of 8 different ICT areas: ICT sourcing, end-user devices & printers, SaaS, data center, network, cloud computing, software & e-services, and ICT governance. The maturity assessment focused on all these areas, while emission calculations were conducted for three areas end-user devices & printers, data centers, and cloud computing. The maturity assessment considered the evaluation of policies, processes, methodologies, and practices used by the IT department of the institutions to adopt green ICT and reduce emissions from the IT systems. The study results implied that accelerating green ICT adoption requires increasing the awareness of green ICT, implementation guidelines and alignment with potential partners, structured governance and targeted funding for green initiatives, environmental criteria in supplier selection and guidelines for green software purchasing and taking environmental considerations into account in hardware and end-user devices.

Table 4. Green IT Reach-Richness Matrix (adapted from Molla, 2009).

	Green IT Rich Dimensions			
Green IT Reach Dimensions		Policies	Practices	Technologies and systems
	Sourcing	The extent to which an organization has adopted an environmentally preferable IT purchasing policy and articulated clear green guidelines for buying IT equipment and services.	The practice of analyzing the green track record of software and IT services providers, incorporating green considerations in vendor evaluation and IT procurement decisions	Information systems that track, monitor, and analyze the carbon footprint of suppliers such as supplier sustainability assessment tools.
	Operations	Encompasses the extent to which the services provided by the IT infrastructure support issues	Green IT operation practices refer to eco-considerations in operating the IT and network	New technologies and systems for (a) reducing the energy consumption of powering and cooling

		encapsulated in business sustainability. Some of the policy considerations include PC power management; policy on staff computer usage and green data centers.	critical physical infrastructure in data centers and beyond and operational actions designed to improve the energy performance of corporate IT assets.	corporate IT assets (such as data centers) (b) optimizing the energy efficiency of IT assets (c) reducing IT induced greenhouse gas emissions (d) supplanting carbon emitting business practices and (e) analyzing a business's total environmental footprint.
	End of IT life management	End of IT life management policy.	Reuse (extend life), refurbish, recycle, or dispose IT hardware.	Information systems that track the life cycle of corporate IT assets and analyze the cost-benefit of different disposal methods.

2.3 Sustainable sourcing and supplier selection

Sourcing is an activity of supply chain management that consists of the management of the supplier and getting the goods from the supplier to the buyer's premises (Giunipero et al., 2019). In the context of sustainability, sustainable sourcing is defined as:

> The act of taking responsibility for the environmental, social, and/or economic consequences of purchased goods and services by obtaining the best value for money, while purchasing the most sustainable goods and services from the most sustainable suppliers, in support of the organization's stated purpose and strategic goals. (Sustainable Purchasing Leadership Council, 2024)

Sustainable sourcing thereby reflects the organizational alignment of their sourcing into processes and policies to factors of sustainability dimensions; economic, environmental, and social (Welz & Stuermer, 2020). According to International Organization for

Standardization (2017), sustainable sourcing is a process where the decision-making of goods and services benefits both, the organization and the society when aiming for minimized impact on the environment. The EU has taken a stand and guides sustainability in public procurement and defines green public procurement (GPP) as a process of procuring goods and services that have a lower lifecycle environmental impact than would be achieved through traditional procurement (European Commission, n.d.b). Indeed, through sustainable public procurement, the perception has emerged that sustainable sourcing is seen as an attempt to respond to social, economic, and environmental concerns (Sönnichsen & Clement, 2020).

Schneider and Wallenburg (2012) argue that sustainable sourcing in the organization can be considered as employed only if all three dimensions of the triple bottom line of sustainability, economic prosperity, environmental protection, and social responsibility, are realized in the sourcing process. Achieving the emphasis of all dimensions requires both, increasing the number of sustainability criteria in the sourcing process and increasing the number of activities in sourcing that expressly take sustainability criteria into account (Schneider & Wallenburg, 2012). EcoVadis (n.d.) which provides business sustainability ratings, defines that sustainable sourcing as an act of integrating performance factors of social, ethical, and environmental into the supplier selection process. Sönnichsen and Clement (2020) point out that the implementation of sustainable and circular sourcing requires the presence of actors who see the potential of sustainability and are supported by the organizational structures and methods.

In prior studies are implied that benefits from sustainable sourcing are the value created for various stakeholders both inside and outside of the organization as the organization’s environmental and social performance improve, increase in productivity (Boruchowitch & Fritz, 2022), and purchasing function’s opportunity to enhance its strategic position within the organization (Schneider & Wallenburg, 2012). There are differing opinions on the extent of sustainable procurement benefits, as the direct impacts are mainly channeled to the supplier and only gradually affect the organization's performance (Eltayeb et al., 2011). However, initiatives that benefit suppliers, such as green product design and product returns, can also correlate to benefits of end-user organizations such as reduced amount of waste generated, and gained economic benefits such as cost savings and success in social sustainability. Schneider and Wallenburg (2012) argue that the reason behind the differing opinions and lack of implementation of sustainability into sourcing can be either the low awareness that sustainable sourcing can impact the development and success of sustainability within the organization, or if the organization is conscious of this correlation, they do not have enough competence or resources to implement sustainability into sourcing processes (Schneider & Wallenburg, 2012).

Supplier selection is defined as one of the most critical and important activity in supply chain management (Hasrulnizzam et al., 2014; Taherdoost & Brard, 2019). It is a process that impacts the success of the organization when they identify, evaluate, and make contract with the selected supplier (Taherdoost & Brard, 2019). Supplier selection is defined as the first step of supplier development which implies an evolving collaboration with the supplier in the supply chain the collaboration with the supplier (Hasrulnizzam et al., 2014). The purchasing company aims in the process to maximize the value and build strong, long-term relationship with the supplier (Taherdoost & Brard, 2019). Zimmer and others (2016) define that sustainable supplier selections consist of four tasks (Figure 4). The tasks start by identifying needs and specifications which is followed by formulating the criteria that are used for evaluation of the supplier and later in supplier monitoring and development. Potential suppliers are evaluated based on the criteria and continue by later evaluation and final selection between the qualified suppliers.

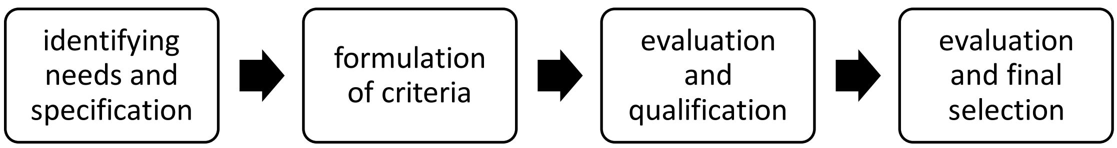

Figure 4. Phases of sustainable supplier selection (adopted from Zimmer et al., 2016).

Through supplier evaluation practices, companies can assess suppliers' sustainability performance and get an indication of their compliance with the company's sustainability standards and requirements (Grimm et al., 2014). An increased environmental consciousness in society, competitive markets (Hasrulnizzam et al., 2014), and pressure from various stakeholders (Zimmer et al., 2016) have influenced organizations to consider sustainability in supplier selection. Behind this change is also the acknowledgment that well-planned and thorough supplier selection can have a positive impact on organizational performance and make a strategic difference in their competence (Taherdoost & Brard, 2019). Taherdoost and Brard (2019) acknowledge that the criteria defined and used in supplier selection, together with the right selection methods, are the decisive factors for the growth and competitiveness of a company.

In the prior literature, studies on sustainable supplier management that consider the criteria formulation and used in the selection process have been conducted since 1997 but it is seen as a young area of research (Zimmer et al., 2016). The studies have followed similar themes of each sustainability dimension, environment, social and economic. Major of the studies, consider supplier selection criteria from the economic aspect and least from the social aspect (Zimmer et al., 2016). The result is not surprising, as in traditional sourcing, factors guiding the supplier selection are quality, delivery performance, cost, and capability (Taherdoost & Brard, 2019). The cost as an economic factor has been the guiding factor for a long time, but the supplier selection has risen to a much higher complexity level various factors such as environmental, social, political, and customer satisfaction have been added to the selection process (Taherdoost & Brard, 2019; Zimmer et al., 2016). The growing number of criteria in supplier selection requires organizations to make decisions about which criteria will have the most impact on decision-making in supplier selection (Hasrulnizzam et al., 2014). Every supplier selection process and primary factors in it may vary depending on the situation (Taherdoost & Brard, 2019). Table 5 lists the 10 most common supplier selection criteria that Zimmer and others (2016) compiled from the research on sustainable supplier management.

Table 5. Top 10 most common criteria in sustainable supplier management (adapted from Zimmer et al., 2016).

Economic criteria	Environmental criteria	Social criteria
Quality Flexibility Price Lead time Relationship Cost Technical capability Logistics costs Reverse logistics Rejection ratio (ppm)	Environmental management system Resource consumption Eco-design Recycling Controlling of ecological impacts Wastewater Energy consumption Reuse Air emissions Environmental code of conduct	Involvement of stakeholders Staff training Social management commitment Health and safety Stakeholder relations Social code of conduct Donations for sustainable projects The rights of stakeholders Safety practices Annual number of accidents

Further, collaborating with suppliers and engaging suppliers to reduce emissions along the value chain is one way to address and disclose an organization's Scope 3 emissions. (Farsan et al., 2018). This can be considered as a collaboration practices (Grimm et al., 2014) which differ from the assessment practices in a way that they aim to mutually improve the relationships, practices, and capabilities in the supply chain. Farsan and others (2018) present that to succeed in the collaboration, organizations need to plan and implement a supplier engagement strategy. Part of the collaboration is the communication of the expectations to the suppliers. There are various types of methods how to communicate with suppliers: company-set standards, promoted action, joint venture/project, third-party standards, and rating/scoring system. Company-set standards and third-party standards are considered as a forceful methods as they set certain requirements for the suppliers while rating/scoring system is considered as a comparative assessment method of suppliers. Promote action describes a means to influence a supplier's emissions in a way that reduces emissions. Typically used in situations where suppliers do not have a high level of maturity in promoting sustainability. Joint venture/project on the other hand is considered as a complementary method to others that is typically used when the companies have related activities with the supplier (Farsan et al., 2018).

2.4 Implementing environmental sustainability in ICT sourcing

Enterprises are encouraged to apply environmental sustainability considerations to their ICT procedures of selecting and using ICT services and equipment (Eurostat, 2023). This has created the need for better asset management, minimization of waste and GHG emissions, prioritizing energy-efficiency, and circular economy in decision-making. As the amount of purchased IT and services in organizations is rather high, the consideration of environmental impact in supplier selection is significant (Capgemini Research Institute, 2021). The management of IT/ICT suppliers is therefore seen as one of the key levers for environmental sustainability in IT (SustainableIT.org, 2023). In 2022 58.5% of the enterprises in the EU reported that they consider environmental impact when choosing ICT services or ICT equipment (Eurostat, 2023). When looking at the size of these enterprises, environmental impacts are considered to a greater extent in large enterprises than in medium-sized and small. These enterprises that consider the environmental impact when purchasing ICT services or equipment, consider the following characteristics: energy consumption, production material (easily recyclable or recycled materials), energy used in production, recyclability of packaging, and the repairability and durability of the equipment (Eurostat, 2023). These considerations reflect the change in the approach from a traditional linear economic model to a circular economy (Ali & Shirazi, 2023). Product energy consumption and its corresponding GHG emissions are seen as basic criteria in ICT hardware sourcing, but to impact a larger scope of global challenges, it requires broader sustainability considerations about the GHG of whole lifecycle, mineral extraction and use, life cycle length optimization, environmental and social dimensions such as working conditions and child labor (Welz & Stuermer, 2020).

SustainableIT.org (2023) uses an environmental impact model to describe, from IT function level to industry level, the environmental goals categorically for sourcing, emissions, waste, and energy. The goals of these categories can be seen as addressing the main environmental sustainability challenges of ICT and IT, which are outlined in chapter 2.1.1. In the model, targets of the sourcing category relate to sustainability-certified technology suppliers, carbon-neutral technology procurement, and 100% sustainably sourced IT services. For emissions, the targets are for carbon-neutral technology infrastructure, technology to measure and monitor GHG emissions, and fully automated IT services. In terms of energy, the objective is to favor Energy Star-certified hardware, SaaS and cloud-managed IT services and 100% renewable energy. For waste, the objectives emphasize low-impact data center cooling, digitalized documents, and circular lifecycle for all end-user devices (SustainableIT.org, 2023). It can be acknowledged that all categories consist of targets that can be influenced by sourcing decisions and supplier requirements.

At the function level, establishing sustainability requirements for the suppliers exemplifies sustainable operations (SustainableIT.org, 2023). According to Deloitte's (2023) green ICT survey, one of the key priorities to adopt green ICT is sourcing. Related to it, defining, and applying environmental criteria in the selection of hardware is suggested. TIEKE (2022) recommends assessing suppliers' value chain sustainability through questions and requirements. They propose a questionnaire and list of requirements for ICT equipment sourcing that arrives to consider the similar and broader sustainability aspects of ICT equipment: length of the lifecycle, use of recycled materials, reuse of equipment, emissions, and power consumption. The questions assessing the life cycle of equipment consider the extension of equipment life through spare parts and battery replacement, as well as the purchase of factory refurbished or used equipment. Questions on the raw materials of equipment consider the number of refurbished or recycled parts and the amount of recycled material in the raw materials. Purchasers are also guided to ask about the production principles of the raw materials used to manufacture the equipment. Questions are also specified to consider the length of the leasing period and the possibility of two leasing cycles. Questions on equipment recycling consider the fair and safe recycling of equipment and the consideration of data protection.

McKinsey & Company's (2022) study shows that enterprise end-user equipment is one of the main sources of enterprise technology emissions and with changes in the sourcing aspects and actions can reduce 50-60 % of emissions of end-user devices. The study highlights 16 macro levers or means of sourcing that can reduce the environmental burden associated with ICT equipment. These levels are divided into four categories that describe their nature more comprehensively and on a larger scale. Levers 1 to 7 are levers that lay the foundation for sustainable working practices, levers 8 to 11 effectively deploy next-generation infrastructure and technology, lever 12 applies environmentally friendly data handling and software, and levers 13 to 16 reflect the transformation to green energy sources. The levers are further grouped into strategic fields according to their investment and abatement potential. Investment describes one-time investment and recurring costs from high investments to direct savings. Abatement potential describes the potentiality from low to high to reduce GHG reductions through certain levers. Strategical fields are divided into three categories which are 1) quick wins, 2) no-regrets moves, and 3) net zero enablers. The quick wins category describes the levers that can create direct savings and have either low or medium abatement potential. No-regret moves on the other hand can create direct savings and have high abatement potential. Levers in the net zero enabler category have two to three possible scenarios that are low investment and either medium or high abatement potential, or high investment with high abatement potential. An important aspect of the levers is that some of them are alternatives to each other and their potential cannot be counted in total, in this case, the levers cannot be implemented at the same time. The description of the levers and their grouping into a strategic field can be seen in Figures 5 and 6.

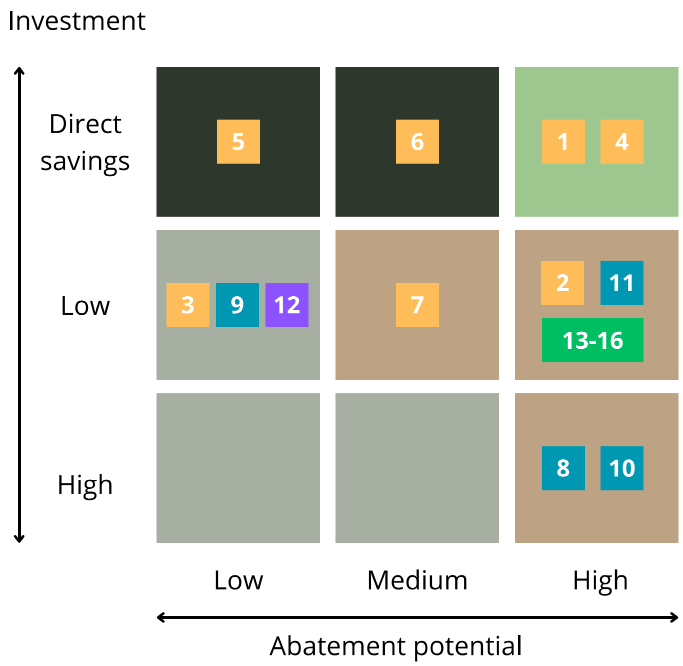

Figure 5. Investment and Abatement potential axis of sourcing levers and strategic fields (adapted from McKinsey & Company, 2022).

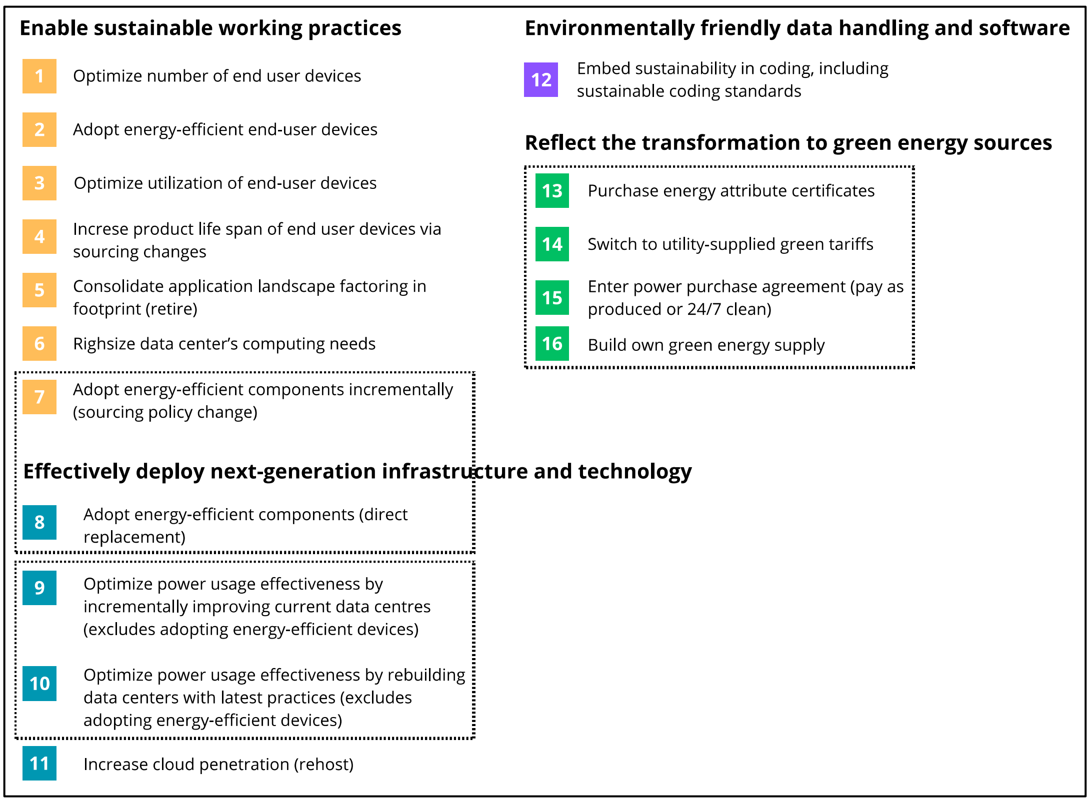

Figure 6. Description of macro levers (adapted from McKinsey & Company, 2022).

2.4.1 Guidelines from a public sector perspective

In the public sector, 57% of the organizations consider environmental impact when selecting the IT supplier, which is higher than in the private sector (Capgemini Research Institute, 2021). Various national organizations and actors such as International Telecommunication Union (ITU), the Finnish Ministry of Transport and Communication, and the European Commission have published guidelines for sustainable public sourcing. In 2023 the ITU published a guideline for circular public procurement of ICT. The focus is to guide the ICT procurement towards cost-effectiveness, minimization of e-waste, maximizing the use of energy-efficient equipment, maximizing the lifetime of the equipment, and equipment recyclability. The ICT sector climate and environment strategy published by the Finnish Ministry of Transport and Communications in 2021, focuses on the same entities as the ITU. In the strategy, sustainable procurement is presented as a means to promote sustainable material flows, the circular economy, and the climate and environmental friendliness of the data economy. For example, the means to extend the equipment lifecycle come from the design, procurement, and increased awareness. ITU (2023) points out that, planning sustainable and circular economical ICT sourcing may require viewing and taking into use new methods and practicalities. These may relate to lifecycle analysis, sustainability impact mapping, identifying solutions, review of findings, and dialogue with ICT suppliers on the objectives of sustainability. Sourcing planning should also consider and monitor the implementation of international standards and recommendations for sustainability (ITU, 2023).

GPP is a central voluntary tool developed by the European Commission for Member States to promote sustainable procurement (European Commission, 2021). GPP is part of the EU's efforts to promote a resource-efficient economy and is seen as playing a key role in this regard. Previous research findings on the use of GPP in the public sector emphasize that suppliers play a significant role in achieving the environmental goals of a large proportion of organizations (Singh et al., 2024). Singh and others (2024) justify this by the fact that suppliers represent the front line in minimizing waste and environmentally responsible innovations. Thus, environmental requirements communicated by the customer can lead suppliers to pay more attention to environmental aspects. This argues in favor of integrating environmental considerations into strategic decision-making in terms of supplier selection and compliance with GPP, which is seen as increasing the capacity to contribute to building an environmentally responsible society (Singh et al., 2024).

The GPP contains a set of principles and criteria for individual product groups for use by purchasers (European Commission, 2021). One of the product groups for which criteria have been prepared are computers, monitors, tablets, and smartphones. The criteria consider the most significant environmental impacts during the life cycle of this product group and aim to improve the environmental performance of the product (Felice et al., 2021). The criteria therefore divided into four categories to address the environmental impacts of the lifecycle: product lifetime extension, energy consumption, hazardous substances, and end-of-life management. Customers have less opportunity to directly address the environmental impacts of production but by considering the reuse of the product, it is possible to indirectly impact the total impacts of the manufacturing phase when new products are made and by extending the lifecycle of the product (European Commission, 2021). As an approach to indirectly impact and address the environmental impacts, the GPP approach lists the following issues: extending services and warranty, product durability, upgradeability and repairability, useful life extension or in other words reusability, purchase of energy-efficient designs, refurbished equipment and products with low amount hazardous substances, and end-of-life management planning to increase resource recovery.

2.4.2 Standards and underlying requirements

According to the Institute of Electrical and Electronics Engineering (2021), global standards can support achieving sustainability in all dimensions economic, environmental, and social, as they guide the actors to integrate sustainability into their operations. The EU notes that ICT standards are part of industrial competition and have the potential to bring benefits to industry producers and consumers, as well as increase market transparency (European Commission, n.d.a). The European Green Deal and the New Circular Economy Action Plan see that standards are relevant elements in the collection and sharing of information on materials and components of ICT products and support the ICT industry towards a sustainable circular economy (European Commission, n.d.a). To this is it suggested that use of product passports could be used to enable users and consumers to make sustainable choices about products (European Commission, 2023). The passports would contain information on the materials and components of ICT products, their origin, and end-of-life management.

Various organizations and institutions have created standards to support ICT sector to move toward a sustainable and circular economy and to support purchasers to make sustainable choices. The selected standards for evaluation in this study are EPEAT Ecolabel and IEE 1680.1 Standard for Environmental and Social Responsibility Assessment of Computers and Display and ISO 20400 Sustainable Procurement-Guidance. These standards were selected for evaluation based on the EU's Rolling Plan for ICT standardization which consists of standardization activities in the context of a circular economy (European Commission, 2023).

EPEAT is an ecolabel for electronic and technology products, and it is owned and operated by the Global Electronic Council (Global Electronics Council, n.d.). EPEAT has a criterion that assesses the sustainability impact of the whole life cycle of the products. The criteria are science-based and created by combining the research data, and the best practices from the international sector (Global Electronics Council, n.d.). Private and public purchasers from different institutions around the world use EPEAT to make sustainable procurement decisions (European Commission, 2023). Products that get registered as EPEAT Climate+ are either gold, silver, or bronze leveled (Global Electronics Council, n.d.). Each of the levels reflects that the product meets all required Climate Criteria, but the percentage of existing optional criteria varies. In the gold level, at least 75%

of the optional criteria are met, in the silver level, at least 50%, and in the bronze level, up to 50% are met.

The IEEE 1680.1 standard was published in 2018 (IEEE, 2020). The standard defines the criteria for environmental and social responsibility performance for computers and displays. The standard is not only created for manufacturers to use, but also for governments, institutions, corporations, and consumers. Throughout the standards, various stakeholders can identify and make purchasing decisions for products that reflect environmental and social responsibility management. The IEEE 1690.1 standard (IEEE, 2022) criteria relate to:

> [--] substance management, material selection, design for end-of-life, product longevity/life-cycle extension, energy conservation, end-of-life management, packaging, life-cycle assessment, and carbon footprint, corporate environmental performance, and corporate social responsibility. (p.9)

ISO 20400 standard is a guidance that provides a framework for integrating sustainability into sourcing and it is applicable to any type of organization (ISO, 2017). The guidelines cover the political and strategic aspects, the means to align sourcing with the goals and objectives of the organization, and how to enhance the culture of sustainability. The benefits that the use of ISO 20400 can bring relate to an organization's ability to impact positively society by reducing the environmental impact of their operations, managing supplier relationships, balancing long-term costs, and improving purchasing behavior (ISO, 2017). It also supports the organization to identify and manage sustainability risks in the supply chain and decision-making. The guideline does not consist of the requirements for the suppliers, but it supports purchasers to define the sustainability criteria in their sourcing processes.

Besides the standards, organizations and corporations are guided toward environmental sustainability through directives. European Commission made a proposal for Corporate Sustainability Due Diligence Directive in the early beginning of 2022 and reached a provisional deal in December 2023 (Council of the European Union, 2023). When the directive enters into force, it will affect EU companies and non-EU companies operating in the EU internal market (Kilsby & Puzniak-Holford, 2023). At the core of the directive are obligations on large companies, their subsidiaries and business partners whose operations have an adverse impact on human rights and the environment (Council of the European Union, 2023). With due diligence, it is aimed to lower the risk of business operations, products, or services that have an adverse impact on responsible business conduct (Organization for Economic Co-operation and Development, 2018). Companies are required to conduct due diligence in their corporate-wide operations (Kilsby & Puzniak-Holford, 2023) and design their business model and strategy in line with the Paris Climate Agreement (Council of the European Union, 2023). Considering the relationship between the business and the adverse effect is an important part of complying with the requirements of the directive (Organization for Economic Co-operation and Development, 2018). How a company should respond to an impact arises from determining whether the relationship to the impact is directly caused by the company, contributed to by the company, or caused by a business relationship. An impact caused by the company itself requires direct action or the cessation/prevention of a potential impact. A contributed to by the company on the other hand requires either the cessation/prevention of the potential effect or the use of leverage to mitigate the remaining impacts. For an impact directly linked to the company’s operations, products, or services through a business relationship, the company should strive to influence the factor causing the adverse effect to prevent or mitigate the effect (Organization for Economic Co-operation and Development, 2018).

3 Research methodology

This study was conducted with a qualitative approach and action design research methodology. Typically, in qualitative research questions "what" and "how" are addressed to present the problem and describe the solution, and its inductive nature highlights the importance of the collected data (Juhila, 2021b). Even the qualitative research is considered empirical in nature, it also has its deductive characteristics as when analyzing the data, the findings are reduced by examining the data in the light of its theoretical framework and research questions set (Alasuutari, 2011; Juhila, 2021b). Theory in the qualitative study describes the adaption of theory to the scope of the study, what the prior literature and research have presented on the topic under study, and the theory of the methods used (Juhila, 2021a). Qualitative research aims to combine the findings from the data by looking for common features or regularities (Alasuutari, 2011). Data can be collected through different situations which makes it multilevel and complex but enables viewing the data from several perspectives (Alasuutari, 2011). According to Alasuutari (2011), after the findings have been reduced to their essentials, an interpretation of the phenomenon under study is created. This interpretation seeks to explain and interpret the phenomenon under study in a way that is understandable and makes use of references to research and theories.

ADR was selected to be the systematic approach of the study to answer the research questions. Sein and others (2011) present that ADR emphasizes the interaction with the organization context. ADR method produces an ensemble artifact whose premise is on the researcher's interconnection with the organizational context during the design process (Sein et al., 2011). The artifact is therefore a consequence of design work and contextual factors. ADR is described to be human-centric (McCurdy et al., 2016), as at the core of the method is the ongoing collaboration with the practitioners from the target organization. This research method is ideally suited to this study, as the research questions dictate the study to collect data on the practical measures and potential approaches that can be used in supplier selection to reduce the environmental burden of ICT equipment and enhance the maturity of the organization in terms of sustainability.

As the research questions of this study seek to understand the potential levers and approaches to incorporate environmental sustainability into supplier selection to decrease the environmental burden of ICT, and how does they contribute to achieving the sustainability efforts, the study presents the final artifact as a set of guidelines containing the design principle. The design principles are formulated to describe both the properties of the artifact and user activity. This type of design principal formulation is one of the three ways of how typically information systems design principles are formulated (Gregor et al., 2020). Design principles are either described to enclose the user's use of the artifact, to enclose artifact features, or both. According to Gregor and others (2020, p. 1628), the design principle, when it describes both, user activity and artifact features, tells "[--] *what users should be able to do with an artifact as well as the features the artifact should have to allow that particular user activity [--].*" The guidelines of this study are formed by adopting the structure of design principles that Gregor and others (2020) propose. The components of the structure are aim, context, mechanics, and rationale. The aim describes the actors involved in the use of artifact to achieve a specific aim, mechanics such as act, activities, or processes that lead or allow users to accomplish the aim, rationale describes the justification of the design principle (Gregor et al., 2020).

3.1 Action design research

ADR is an organizational-centered information systems research methodology (Tiainen et al., 2015). ADR combines elements from action research and design research but focuses on the IT artifact creation and takes the design premise from the influence and intervention of the organization (Sein et al., 2011; Tiainen et al., 2015). The key difference between action research and action design research that Sein and others (2011) point out is that action research focuses more on organizational change and understanding the impact of change, while action design research focuses more essentially on the design and evaluation of IT artifacts appropriate to the organization's operations. The ADR is a method of collecting and using design knowledge that arises from the context where the artifact is designed (Sein et al., 2011). Thereby, the focus in artifact design is not only on the researcher’s objectives or theoretical background but rather the impact of the context because of the ongoing involvement of users.

The ADR method divides the artifact creation into four stages that altogether seven principles guide (Sein et al., 2011). These stages are divided into 1) problem formulation, 2) building, intervention, and evaluation (BIE), 3) reflection and learning, and 4) formalization of learning. Figure 7 illustrates these four stages and the stage-specific principles.

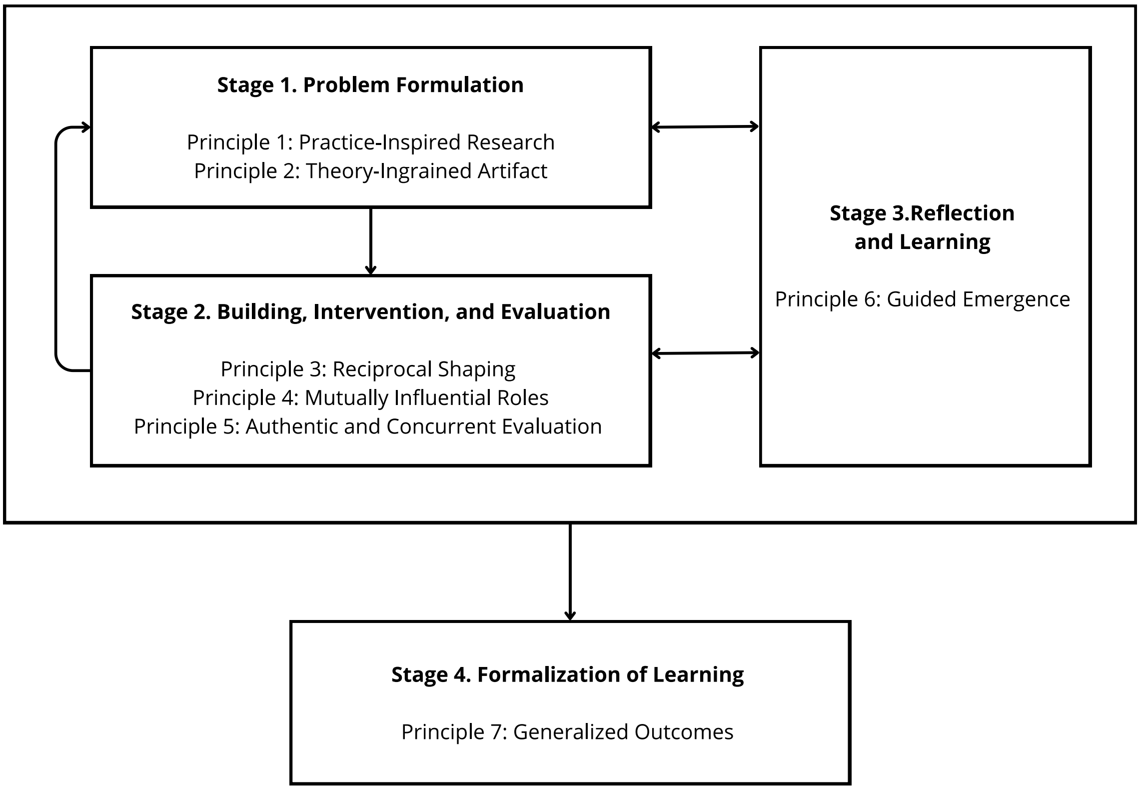

Figure 7. Action Design Research Method (adapted from Sein et al., 2011).

The first stage, problem formulation, begins with an identified problem that, for example, the practitioners have practically detected. The stage follows two principles: practice-inspired research and theory-ingrained artifact. According to Sein and others (2011), practice-inspired research sees that the ADR method views the problems as an opportunity to add knowledge that can be applied to a larger context by examining a specified problem within the context. Theory-ingrained artifact principle describes that the premise of the artifact lies in theories by which creation and evaluation are carried out.

However, at a later stage, the theory-ingrained artifact is set to fit the organization's practices to continue its development through organizational intervention and evaluation. The problem formulation stage thereby is divided into six tasks that build the baseline before moving to the second stage. The first task for the researcher is to identify the research opportunity and put it into context, which allows the second task, the setting of research questions, to be carried out. The third task is to set the research problem within a wider class of research problems so that it realizes the characteristics of the ADR to investigate a wider context through a specific case. The fourth task is to compile the theory and any known prior technological benefits for the study. The fifth and sixth tasks relate to preparing the organizational context for the research, firstly by ensuring the organization's long-term commitment to the research, and finally by defining roles and responsibilities among those involved in the research. The problem formulation stage builds a baseline for the second stage, building, intervention, and evaluation.

The second stage represents the iterative process in the research environment, which results in a realized design of an artifact (Sein et al., 2011). The stage is also described as the BIE phase which stands for building, intervention, and evaluation. During this phase, the artifact is designed, the organization is involved, and there is a continuous evaluation of the problem and the artifact. The BIE constitutes a set of cycles that are executed and in which the results of previous cycles are used as a basis for subsequent cycles (McCurdy et al., 2016). This phase includes the definition of design principles, which means that the researcher defines the principles that should guide the design and be considered throughout the design process (Sein et al., 2011). The principles should be defined in a way that they can be used in other studies of the same class of problems. The context from which the innovative changes and developments of the artifact BIE stage take the most influence and are dominated is also selected in stage two. The research can be either IT-Dominant or Organization-Dominant. According to Sein and others (2011), the premise of the dominancy significantly affects the research design, as the nature of the dominancy differs. The IT-dominant approach emphasizes the design of technology with limited organizational intervention whereas the organization-dominant approach emphasizes the organizational intervention and aspects. Stage two also has principles which are reciprocal shaping, mutually influential roles, and authentic concurrent evaluation (Sein et al., 2011). Reciprocal shaping addresses that both the design of the technological artifact and the context together influence the research process with their inseparability. Mutually influential roles describe the equal importance of research participants in progress, regardless of their role: the researcher brings more theoretical knowledge to progress, while the practical knowledge comes from the practitioners involved in the research. Authentic and concurrent evaluation underlines the relevance and continuity of evaluation as part of the research process.

Reflection and learning is a third stage of the ADR process where design and possible redesigns are examined and happen in parallel with the first and second stages (Sein et al., 2011). The stage occurs in parallel to actively engage in informed reflection to ensure that knowledge enhancement of the identified problem can be implemented holistically, and not just on the artifact being implemented. The stage follows the principle of guided emergency that describes the interaction between the intentional input of the researcher and the intervention of the organization. McCurdy and others (2016) describe guided emergence as encouraging researchers to critically examine the implementation of the principle. This links to the second task of the stage that Sein and others (2011) have formulated to evaluate adherence to principles. The final, third task of this stage is to analyze the results of the research process intervention against the objectives set.

In the fourth stage, formalization of learning, the researcher compiles the achievements and results of the research (Sein et al., 2011). This step follows the principle of generalized outcomes, which aims to describe the problem and solution generically and abstractly (McCurdy et al., 2016) so that they are seen as instances of problem and solution classes (Sein et al., 2011). This is achieved by following five tasks of the stage that Sein and others (2011) present: 1) abstract the learning into concepts for a class of field problems, 2) share outcomes and assessments with practitioners, 3) articulate outcomes as design principles, 3) articulate learning in light of theories selected, and 5) formalize results for dissemination.

3.2 Data collection and analysis

As pointed out, in ADR, the design of the artifact can have more dominancy either from theory or from the organization (Sein et al., 2011). In the context of this study, the artifact is determined as organization-dominant, which describes that the design knowledge and data are collected iteratively in the organizational context. The theory and its contribution are not excluded from the study, but the intervention of the organization has a significant role in the design process. For this study, the theoretical framework is created by reviewing the prior literature on the topic under study. The academic and scientific foundations, accessible research articles, and reports of this study are mainly retrieved from the centric databases of information systems. In addition, reports from the European Commission, the Finnish government, and associations focusing on sustainable development have been used to compile the theoretical framework. The perspectives and theories selected for the research are reasonable in terms of solving the research problem and answering the research questions.

Workshops were chosen as the data collection method for the study. Workshops were seen as an appropriate way to carry out the collection of the data as well as the development of the artifact as workshops are qualitative in nature and participants typically work together to advance a goal, such as redesigning business processes (Thoring et al., 2020). The choice of method was guided by the BIE cycle principles of the inseparability of the designed artifact from the context, equal importance of the research participants, and authentic and concurrent evaluation. The workshops aim to produce research data that captures the interventions of the organization and, through analysis, can be used to develop the artifact into its final form. The data is collected in three workshops in total, that is held once a month. Time reserved for each workshop is 1 and ½ hours. Workshops are organized virtually in Microsoft Teams. To the workshops practitioners from four different areas of the case organization are invited. The practitioners represent the business areas of development management, workplace services, sourcing and partnership management, and operations development. In addition, a sustainability expert, responsible for the company's, which the case organization is part of, core business sustainability development, is invited. The number of case organization's representatives in the workshops varies between 5 and 9 people, due to the time constraints of the invitees. The number of participants and represented areas of responsibility per workshop are presented in Table 6.

Table 6. Number of participants per workshop.

Workshop	Number of participants	Represented areas of responsibility
Workshop 1	5	Development management (3) Workplace services (2)
Workshop 2	8	Development management (4) Sustainability (1) Workplace services (3)
Workshop 3	9	Development management (4) Operations Development (1) Sourcing and Partnership management (1) Sustainability (1) Workplace services (2)

Workshops are used to build, intervene, and evaluate the design of the together, and in parallel reflect the learning outcomes. The structure of the workshops consists of an introduction, individual exercises, and group discussions. At the beginning of each workshop the planned schedule, status of the design and findings from the previous workshop are presented, with the exception of the first workshops where the identified problem is reviewed. The workshops represent stage two of ADR, *building, intervention, and evaluation*. However, the third workshop differs in part from the first two in that it seeks to bring together the lessons learned from both the BIE stage and the problem formulation stage. The third workshop is based more on the objectives of the third stage of ADR, *reflection and learning*. Reflection and learning actions take place throughout the design development process and are presented in the workshop analyses, but the third workshop aims more strongly at describing a holistic reflection on what has been learned. The data generated from the workshops will be both, verbal responses, and written responses on virtual post-it notes. After each workshop, the data will be analyzed to identify the most relevant themes to be used in the development of the guidelines. To ease the data analysis, the workshops are recorded with the consent of each participant.

In the literature, the workshop is seen as an inspiring and potential method of data collection in qualitative research (Ørngreen & Levinsen, 2017). The workshop as a research method supports research in business research (Storvang et al., 2017) and research related to the design of future processes such as organizational change or planning (Ørngreen & Levinsen, 2017). The workshop is considered to be related to action-oriented methods such as action research, participatory design, action learning, and focus groups (Storvang et al., 2017). The workshop as means in research is to get people together to ideate and learn about a domain-specific issue (Ørngreen & Levinsen, 2017). Typically, the stakeholders of the workshop are the researcher, facilitator, and participants, but the roles can overlap (Storvang et al., 2017). In a workshop, the researcher can have a role of facilitator that guides the participants to discuss the specific issue or subject, and moderates and encourages the discussions between the participants (Ørngreen & Levinsen, 2017; Storvang et al., 2017). In this study, the researcher has a role of facilitator in the workshops.

Storvang and others (2017) present a framework for workshop that is used in business research. Framework is divided into four phases of action as follows: diagnosis, planning, the facilitated workshop, and analysis. Diagnosis emphasizes the importance of understanding the research problem and the value that the workshop can bring to it. In this phase the participants for the workshop are selected and expectations for them are set.

In the planning phase, the structure of the workshop is designed, and the content such as exercises is planned. In the third phase, the workshop is facilitated, and participants are involved in a process in which they work towards common, planned objectives through workshop activities such as discussions or exercises. The analysis of workshop consists of an evaluation of the workshop which aims to process and analyze the data. This step aims to choose the right ways to process the results and participants' perspectives considering the research questions (Storvang et al., 2017).

Workshops differ from observations and interviews in a way that the documentation of the data is challenging to process as the issue is approached in various ways (Ørngreen & Levinsen, 2017) and the amount of data is large (Storvang et al., 2017). The data is qualitative and gathered from the participants from the workshops can be either outcomes of the dialogs and discussions, visualizations, or drawings of the issue (Storvang et al., 2017). To ensure quality documentation, in this study the workshops will be recorded, and the outputs produced on the working platform, such as the participants' written responses, will be stored for analysis. Data analysis in qualitative research can be carried out at the same time as the data is collected (Hirsijärvi et al., 2009). Data can be collected at different stages of the research process, which means that data analysis can also be divided into several stages. In visual terms, data analysis takes the form of a spiral pattern instead of a linear pattern. In this study, the data is analyzed in three different stages, in principle after each workshop, using thematic analysis as a method of analysis. Thematic analysis is one of the most common methods of analysis of qualitative data (Hirsijärvi et al., 2009). The analysis results in a theme that describes recurring topics in the data. The purpose of the analysis is therefore to identify key themes and typical features in the data (Juhila, 2021c), divide the data and group it into different themes (Tuomi & Sarajärvi, 2018). A characteristic of theming is that once the themes have been identified, it is possible to see which issues occur within each theme (Tuomi & Sarajärvi, 2018).

Data analysis in this study starts by reviewing and summarizing the results of the workshop. It is followed up by analyzing the data in the light of the research questions and using data-driven analysis. Data-driven analysis allows to observe issues that may have merged outside the research questions. The data is divided into categories based on the identified themes that emerge and names to describe the categories are created. Details of the categories will be opened in text form and direct quotes from participants presented. The same process will continue after each workshop until the third workshop.

3.3 Reliability and validity

The reliability and validity of the results of studies may vary, which is why the reliability of the study must be assessed (Hirsjärvi et al., 2009). According to Kananen (2013) the concepts of scientific credibility are reliability and validity. Reliability describes the consistency of the results or that the study and its results are reproducible. Hirsjärvi and others (2009) define that reliability does not give random results. Validity of the study describes whether the results are correct (Saunders, 2007) and whether the explanations and interpretations used to describe the steps and results of the study are compatible (Hirsjärvi, 2009).

Kananen (2013) points out that in the premise of the credibility of the study is accurate documentation that answers to the questions of what, why and how. It is suggested that the researcher documents and keeps notes on the different stages of the research and related activities. It is typical in the qualitative studies that the researcher describes specifically the phases of the process and how they have arrived at their results (Hirsjärvi, 2009). An accurate description of the study adds to its reliability. To ensure reliability and credibility, this study aims to provide a thorough description of the research process, highlighting the details and justifying the findings. The implementation of the study in a case study organization is presented step-by-step to ensure that replication of the study is possible.

Typically, the evaluation of workshops is often carried out unsystematically or inconsistently (Thoring et al, 2020). As the workshop is used to design and evaluate the artifact of this study, it is needed to critically examine the consistency of the results. To ensure the comparability and replicability of the workshop and thus the evaluation of the artifact through the workshops, Thoring and others (2020) suggest five potential evaluation principles: focus definition, role allocation, triangulation, transparency, and reflection. The focus definition principle highlights the importance of defining the aim of the workshop and identifying areas of interest. The role allocation principle guides the determination and clear differentiation of the roles. The triangulation principle implies the use of various research methods and data comparison. The principle of transparency describes the accessibility of the research and its results. The fifth principle, reflection, encourages the researcher to formulate 3-5 observations on the usefulness of the evaluation procedures. In this study, the principles of Throring et al. (2020) have been followed as applied and their similarity with the steps of the ADR method has been noted. These applications and evaluation of the reliability and trustworthiness are presented in chapter 5.

4 Design development process and final artifact

The design development process adopts the steps from the ADR methodology. The process description in Table 7 presents the main stages of designing the guidelines: problem definition, an iterative BIE cycle, a parallel reflection and learning phase and a formalization of learning. The guiding principles and activities of each stage conducted during the development process are also presented.

Table 7. Design development process.

ADR stage	Approach in the study
Stage 1: Problem formulation	**Principle 1: Practice-Inspired Research** Activity: Analysis with case organization practitioners. - Study is driven by the need of the case organization to increase the awareness of their operations sustainability.
	Principle 2: Theory-Ingrained Artifact Activity: Building a theoretical framework. - The theory used is sustainability impacts of ICT, green ICT and adoption in organizations, sustainable sourcing, and supplier selection in the context of ICT.
Stage 2: Building, Intervention, and Evaluation	**Principle 3: Reciprocal Shaping, Principle 4: Mutually Influential Roles, and Principle 5: Authentic and Concurrent Evaluation** Activity: Iterative design development and evaluation of the artifact. - The researcher together with the practitioners includes theoretical and practical knowledge to the design process in the workshops.
Stage 3: Reflection and Learning	**Principle 6: Guided Emergence** Activity: Evaluating the design development process, the implementation of principles and the applicability of lessons learned. - Continuous reflection on learning outcomes though the workshops, and holistic assessment in the third workshop.
Stage 4: Formalization of Learning	**Principle 7: Generalized Outcomes** Activity: Sharing and concluding the learning outcomes. - Determining the contribution of learning outcomes to the case organization.

The design development process is by its nature a continuous transfer of information, and the result of a multi-stakeholder contribution. To illustrate this, Figure 8 has been produced to illustrate the development of the artifact and the flow of information, showing the contribution of practitioners to different versions of the artifact at different stages of its development. The contribution of those involved in the design of the artifact has been divided according to the ADR methodology, with the researcher's contribution being the design principles and theoretical basis, while the contribution of the case organization representatives to the artifact being designed is the practical expertise and knowledge.

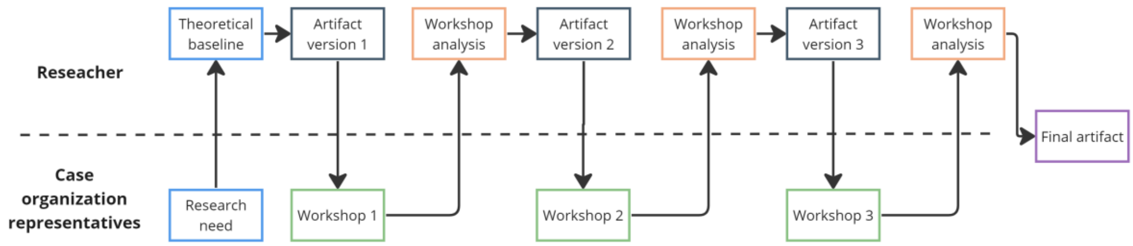

Figure 8. Design development process and information flow.

4.1 Problem formulation

The problem formulation was conducted at the beginning of the study together with the practitioners from the case organization. The case organization had acknowledged the need to increase its maturity in the environmental sustainability of ICT and identify areas where concrete actions can be taken to reduce the carbon footprint of its operations. Collaboration with the university was seen as potential means of moving towards this goal, and thus research in the form of a master’s thesis was chosen as a starting point for this goal. The case organization’s commitment to the research was reinforced already in the beginning by the appointment of two supervisors from the development management team and professional in charge of the global PC lifecycle process. Their role in the study was set to give input to the design process with their practical expertise and knowledge. Together with the researcher they formed the core ADR team. The researcher participated in discussions with the ADR team and key stakeholders, in which it was noted that sensible approach is to limit the study to one area of the case organization's operations while keeping as a sub-objective to raise the overall awareness about the ICT and sustainability and case organization's role in it. The study was thereby guided by the need to examine the sustainability of ICT equipment sourcing and supplier selection. At this stage it was identified that the key stakeholders of the study come from the case organization's development management and workplace services areas.

The discussions continued to examine the as-is state of ICT equipment sourcing and it was indicated that the case organization uses sustainability as a criterion in supplier selection, but the criterion does not have clear underlying objectives and secondly, there are no structured guidelines for integrating sustainability considerations into sourcing. There are no specific sustainability requirements for suppliers to meet, no specific standards are required or set of questions asked about their performance on sustainability. In the supplier selection process, it is required that the supplier can demonstrate and prove their alignment with the case organization's key strategic objectives and values. When examining the as-is state in the case organization's ICT equipment sourcing and supplier selections means, the problem formulation could be made, and the initial objective set for the study was set design guidelines to support the sustainability considerations of these processes. The problem formulation is presented in Table 8.

Table 8. Identified problems and their appearance in the case organization.

Problem	Appearance in the organization
No clear means or understanding of how to integrate environmental considerations into the organization's own operations	- Sustainability is strategic objective of whole company but not visible in the ICT strategy. - No dedicated sustainability professional.
Sustainability is not identified as relevant/critical focus are on organization's operations	- Sustainability is considered as a "nice to have" element and does not have that extend impact on way of doing business in the context of ICT.
Limited knowledge of potential ways to reduce the environmental burden of ICT equipment	- No clearly defined means to reduce the environmental burden associated to ICT equipment.
Sustainability as a criterion for equipment sourcing and supplier selection unclear	- Sustainability as an on-off criterion, no commitment to standards. - No resources to focus on the details of supplier's environmental responsibility and performance - Absence of guidelines and defined requirement to guide equipment sourcing and supplier selection with attention to sustainability aspects.

After the case organization's current state was examined and objective was set, the study proceeded to analyze the theory behind ICT and sustainability, the means to reduce the climate- and environmental burden of ICT from the perspective of the purchaser and user, and sustainability in sourcing. In terms of existing theories and paradigms, the research opportunity was identified and conceptualized. The relevance and importance of the topic emerged from previous research, and the research opportunity could be conceptually linked to green ICT and sustainable and circular sourcing means. The created theoretical framework guided the setting up of the research questions, and as Sein and others (2011) present, the use of previous literature and research support the problem definition by structuring the problem, identifying possible solutions, and building the design of the research artifact. It was noted that the research problem can be structured to align with the larger class of problems: the dual impact of ICT on sustainability and corporate social responsibility. The possible solutions that were brought up in the studies imply the importance of the circularity and overall sustainability awareness.

4.2 Building, intervention and evaluation

The first workshop was held at the end of January 2024. To the workshop participated the core ADR team, and representatives from the areas of development management, workplace services. The workshop consisted of three phases: reviewing the problem definition and the theoretical framework, a discussion on current sustainability practices of ICT equipment suppliers, and an exercise that aims to identify potential sustainability aspects of supplier selection. The analysis of the workshop started by summarizing the discussions and outcomes of the final exercise. The key themes that occurred from the analysis are divided into following categories:

1. Challenge of supplier comparison
2. Mirroring the ideal
3. Influencer impact
4. Top-down driven culture of sustainability

At first, the results of the problem definition phase and the theory and paradigms built around the research were presented to the participants. After it, the workshop proceeded to phase in which participants were asked to share comments and opinions on their views about their current suppliers' sustainability practices. Participants pointed out that it is a challenge to identify the areas of suppliers that have the most impact on sustainability, how they perform in it and how to compare the suppliers based on it. To this, the participants ideated that some kind of metrics or comparison of the ESG ratings of the suppliers could be a meaningful way to benchmark suppliers. These reflective comments are in line with the observation that supplier selection has become more complex due to increased economic, environmental, and social awareness and expanded evaluation factors as well as various regulatory controls (Taherdoodst & Brard, 2019). This forms the first theme, challenge of supplier comparison.

Participants pointed out that when looking at the purchaser's point of view, the suppliers typically reflect into ideal situations and activities. This view can be seen in the example (1). This example (1) forms the second key theme, mirroring the ideal. The theme brings up the question that does the supplier have competence to ensure that the organizations who buy and use their products, can meet their expectations related to sustainability. In addition, does the customer contribute together with them to environmentally sustainable business operations and ensure for example the environmentally sustainable end-of-life management practices. Thus, what their means are to ensure that organizations can do their part as per recommendations.

> (1) End-of-life cycle and recycling requires customer engagement and action. How much do suppliers mirror the ideal situation, and then what is the reality in organization X as to whether we can act and respond in the way that the targets that the suppliers are setting (Workshop one 30.1.2024.)

Third theme, influencer impact, relates to the ideology that the proactive influence of the organization can have impact on suppliers' sustainability practices. One of the participants described the possibility of proactively influencing the suppliers. If the suppliers know that the sustainability as a requirement or criteria impacts the decision-making in tendering situations, they will put more effort into it at least by being more transparent about their activities. This can be seen in the example (2).

> (2) A good experience from project X was that when we tried to raise the decarbonization criterion, suppliers looked at our sustainability strategy and adapted their own mates to show how their practices fit with our objectives. I felt that we were able to make a difference and it's a visible place to act, when suppliers know that the purchasing decision is based on whether the criteria are met or not, they contribute in a very different way (Workshop one 30.1.2024.)

The final theme that occurred from the discussion is a top-down driven culture of sustainability. Several participants consider that an important factor for taking sustainability into account, both in ICT equipment sourcing and overall, is the willingness of management to make internal improvements in sustainability. There is a need to foster encouraging a culture of innovation and continuous improvement also around sustainability. The third phase of the workshop was an exercise designed to identify potential environmentally sustainable factors that the guidelines could contain. The identification of factors was guided by the perspective of what issues could be of most interest to the case organization or what would be considered important in relation to the environmental aspects of ICT equipment, the sustainability principles of suppliers and the organization's own sustainable ICT activities. As a background to the exercise, participants were briefed on the most common criteria used to assess the sustainability performance of suppliers based on the criteria found from the previous studies and public sector guidelines. The participants identified altogether 10 potential sustainability variables: lifecycle management, end-of-life treatment, prolonging lifecycle, recyclability, and second-hand use, % of recycled materials used in equipment sustainability of materials used for equipment, energy consumption and efficiency (devices, offices, and behavior), packaging, transportation, and transition from data centers to cloud.

Findings from the theoretical framework and analyzed data from the first workshop resulted a preliminary design of the artifact. The initial version of the artifact was designed to include action design principles that support organization's approach to environmentally friendly operations, aligning suppliers with the organization's environmentally responsible visions, and considering the adverse impacts of different phases of the ICT lifecycle in supplier selection. The guidelines are thereby divided into four, each of which is given a descriptive name and associated with a specific design principle. The contents of the guidelines are drawn from both theory and practical observations. The preliminary design of the four guidelines of the artifact is presented in Table 9.

Table 9. Preliminary design of the guidelines and design principles.

Guidelines	Design principle
Implement green ICT ideology and culture	Principle of Green ICT - Build premise for green ICT culture within the organization. - Identify the underlying drivers, increase knowledge capabilities, assess the reach and richness of sustainability practices.
Emphasize goals set by the company	Principle of alignment - Align and ensure supplier's commitment to customer organization's sustainability efforts. - Ensure that the decision criteria's consist of and is aligned to environmental sustainability targets, influence proactively the suppliers, require visibility and strive for mutual contribution.
Select environmentally friendly equipment	Principle of environmental sustainability - Prefer solutions that are designed to be environmentally friendly throughout their lifecycle. - Consider the design, production, packaging, transportation, energy-efficiency, and certificates/standards.
Foster circularity and extend useful lifetime of equipment	Principle of closed loop and longevity - Consider the contribution of both the supplier and organization activities to the circular economy. - Longevity, repairability, and durability, end-of-life management.

In the second workshop the design development process together with the organization practitioners continued. The workshop was held in the end of February 2024 via Microsoft Teams. To the workshop participated the core ADR team, sustainability expert, and representatives from the areas of development management and workplace services. The objective of the second workshop session was to review the findings from the first workshop and through an exercise to evaluate the preliminary design of the artifact. The first half of the workshop was used to present the objectives, participants were motivated by the study need and the importance of the topic, and findings from the previous workshop were presented. The second half of the workshop started by introducing the artifact and the upcoming exercise. In the core of the exercise is to generate a discussion on sustainability and environmental sustainability of ICT within the case organization and find potential ideas to develop the preliminary design outcome further. Participants were guided to consider the contradictions and opportunities of the artifact. The exercise started with individual work and continued with a group discussion. It was realized that there would be a need to have more time for discussion, and it was decided to set aside an extra 30 minutes. The additional discussion session took place two days after the workshop, where participants presented their observations on the artifact, commented on the findings of others and the researcher concluded the workshop.

The data from the second workshop and the additional discussion were similar to the first workshop: verbal observations by participants, discussions between participants and written responses on post-it notes. The collected data was analyzed by making observations on recurring themes. The analysis indicated that the observations and ideas shared by the participants were able to be categorized into 7 different themes. Themes 1 to 3 focus on participants' views on ICT environmental sustainability in general and the views are the outputs of the data analysis of the workshop participants' perceptions of the content of guidelines 1 and 2. Themes 4 to 7 are the outputs of the data analysis of the content perceptions of guidelines 3 and 4. The seven themes were given the following descriptive names:

1. Level of contribution
2. Cultural change and acknowmentedge of the topic
3. Track-recording
4. Leveraging the supplier's know-how
5. Optimized asset management
6. Visibility to the life cycle
7. Longevity and energy-efficient equipment

The first starting point is that participants recognize that in a company whose core business is heavy machinery end-products, the focus and resources for environmental friendliness and sustainability are put on the lifecycle of those products and the core business operations. There is an assumption that there is a magnitude difference of CO2 impacts of ICT and company's end-products which explains why there are no specific sustainability targets set at company level for support organizations. However, participants see that it does not remove the fact that the company has responsibility on their own carbon footprint and there should also be environmental sustainability targets for internal ICT operations. Participants pointed out that there should be a discussion on how the case organization and other support functions of the corporation want to emphasize the contribution. These views are shown in the following example (3).

> (3) There should be a sustainability related target. It's still important and relevant, but maybe also because of the magnitude is not so high compared to other areas of the business. That is one reason why there is not the explicitly been a separate target sustainability related to ICT. Maybe it's each function need to think about themselves like we do here now for ICT. What is their role? What is the contribution and what can be achieved by integrating this into our way of working? (Workshop two 27.2.2024.)

As shown in example three, the case organization should consider for themselves what kind of contribution they should and could make, and what the impact would be. This shows that the goal of promoting greening and sustainability in ICT needs to be integrated into operational planning. This vision reflects the way in which a green ICT mindset or way of working can be holistically incorporated into a company's operations, decision-making and processes (Ning & Khuntia, 2023). Participants see that being proactive, increasing awareness of green ICT and its impacts can support the management team to set targets for environmental sustainability. As the case organization has not defined specific requirements for ICT sustainability or actions to promote it, participants see that beyond discussion about the contribution level, the most important thing is a change in attitude, trust in one's own beliefs and foster open communication. This is reflected in example (4).

> (4) We can take the attitude that we are pioneers within the organization to report our own savings in terms of CO2 emissions or sustainability issues. Even if there's no interest now, there will certainly be later and what's better that we can be pioneers and lead the way a little bit, listen to the company strategy and bring things forward. We can do these things because of our own conviction because we believe that this is the right thing to do (Workshop two 27.2.2024.)

In the view of the workshop participants, the designed guide will play a role in growing awareness of ICT sustainability within the organization and will bring acknowledgement of the importance. Participants referred to the guide as “awareness material”, which in a way motivates the topic and creates generic awareness. In addition, they point out that if the sustainability can be placed as a driving factor either in the strategical level or as a mindset, it can foster the successful integration of sustainability into practice. This view is reflected in the examples (6) and (7).

> (6) Already when we are having the guide then it’s like we are being acknowledging the importance of the topic and we will be also growing the knowledge of the organization on this topic (Workshop two 27.2.2024.)

> (7) If we can get sustainability driven as a strategy or mentality in our company it will make a big difference. I hope that as a company we would lead through it and make it an important issue, so things will change in practice (Workshop two 27.2.2024.)

Participants see that implementing sustainability and raising awareness requires monitoring and documentation of existing practices, and the ability to respond proactively to legal requirements. It is certain that sustainable values are already being implemented today, but they are not emphasized, or decisions are not taken simply because of them. As a part of adopting green practices in the organization is the assessment of the reach and richness of the existing green practices (Molla, 2009). Molla (2009) states that by assessing the green readiness of an organization, it will be combined with an understanding of the level of adaptation and support the identification of possible strategic pathways. By keeping track of what is already being done, it is possible to understand the current situation and, even before the arrival of internal or external requirements, to know what level of sustainable ICT is being implemented and what the history behind the activities is. Examples (8) and (9) related to these views.

> (8) Get active before the legislation comes in, because that way we're in the driver's seat than the passenger seat. If you are not prepared for the legal requirements, then you will be forced to do something, and often at great expense. At the same time, these issues can be used to build new and good business opportunities (Workshop two 27.2.2024.)

> (9) We would need to keep track of the things we are already doing so that we are not in a situation where we have already done all the low hanging fruits and have nothing in our pockets. At this point we need to have a story that says that from 2024 we've started doing certain things (Workshop two 27.2.2024.)

To tracking and documentation view, participants see that collaborating with the supplier and learning from them is significant in the path to greener direction. Participants see that it is likely that suppliers are further along the path to ICT sustainability as their business core is in ICT. The pursuit of mutual benefit and contribution to sustainability should be part of supplier discussions, and the requirements for suppliers could include criteria that encourage this. Example (10) highlights this matter.

> (10) We can learn from ICT suppliers, as for them environmental sustainability has already been a competitive factor for quite a while, with practices and targets set higher than ours. Through this we can raise our own bar (Workshop two 27.2.2024.)

Part of the discussions were comments related to optimized asset management. One participant pointed out a concrete example of a means to foster sustainable practices within the organization by exploring the possibilities for implementing virtual working environments for external consultants to optimize the number of the end-user devices. This view is consistent with the idea that optimized number of end-user devices can have positive impact on the emissions from ICT equipment (McKinsey & Company, 2022). According to McKinsey & Company (2022) optimizing number of end-user devices is a lever that has high abatement potential can bring direct savings to the organization. The example (11) represents this view.

> (11) Optimize the use of assets. Outside consultants are given a new PC even if they have a working PC from their own company. It can be replaced with virtual desktops. It has been mainly a security issue, but that security issue can be solved virtually. There is a cost benefit but at the same time value is improved (Workshop two 27.2.2024.)

Participants made several comments on issues such as the recycling of packaging materials and supplier's design for recycling principles. Recycling of equipment packaging materials is seen as a relatively small part of the overall picture, but participants believe that even the smallest aspects can have a wider impact. Participants questioned that whether there could be something in the guidelines that emphasizes the responsible packaging recycling and suggestions for end-users. Visibility for supplier's design for recycling principles and repairability of the equipment participants see as an important part of understanding the life cycle impacts of the equipment. Participants commented that suppliers need to be motivated to increase the transparency to whole chain of recycling. As noted in the workshop one, suppliers mirror to ideal situations, but what makes the organization curious about is the supplier's practices to ensure the recovery of the resources – what happens to the hardware at the end, where does it end up. Related to this end-of-life management practices, participants see that the organization should not only be conscious of the suppliers' practices, but to agree on the internal end-of-life management policies such as recycling policies of devices, cables, and keyboards, to ensure sustainability after the use phase.

Related to fostering the circularity and option to purchase refurbished equipment, participants view that there is need to be understanding that what equipment are relevant for refurbishing and there needs to be certainty that information security is ensured with these devices. If taking refurbished equipment into use, the end-users need to accept this and understand the reason behind. The participants view that making sure that the equipment is repairable and durable, is a good first step and opportunity to extend the lifecycle. Energy-efficiency was noted as a critical functionality of the equipment. Participants see that although the purchase price may be higher, it should be still as a priority to choose energy-efficient solutions as it has a relation to long use phase and will bring savings and positive impact over time.

The conduction of the second workshop supported the design development, and specifically promoted the reflection and learning which is a one of the key stages and objectives of ADR process (Sein et al., 2011). It can be concluded from the analysis of the second workshop that the practitioners from the case organization are increasingly more capable of assessing the dual impacts of ICT and potential levers to adopt more greener operations. It was also clearly recognized that the case organization needs to examine their level of contribution holistically in the context of environmental sustainability. Their willingness to shift towards more responsible business conduct can be seen, and they consider that increasing environmental sustainability into sourced ICT is a good starting point.

4.3 Reflection and learning

The third workshop was organized in the end of March 2024. Similarly, as other workshops the session was organized in Microsoft Teams. The third workshop differs from the first two in that it concludes the design development process and concludes the learning outcomes with the practitioners. The overall objective of the workshop was to review the designed artifact, collect final development ideas for it and gather comments from the participants holistically on the design development process and learning outcomes. To the workshop participated the core ADR team, sustainability expert, representatives from the areas of development management, workplace services, sourcing and partnership management, and operations development. The workshop started by presenting the key findings from the second workshop and the artifact by comparing to the research questions. The contribution from the practitioners was collected throughout the exercise in which the participants were guided to make observations about the guideline's contribution to practices and whether the guidelines meet the initial expectations set out in the beginning of the process. Reflection was first carried out independently, followed by a group discussion. After the exercise, the discussions were guided to consider the potential next steps related to the ownership of the guidelines and communication about the outcomes. In the end of the workshop participants were guided to reflect the design development process and collecting short comments from the participants. When analyzing the input from the participants to the exercise, discussion on next steps and learning outcomes three descriptive themes can be defined.

1. Foundational characteristic
2. Extendibility
3. Suitability of the research method

The first theme, the foundational characteristics, consists of participants views on the nature of the guidelines, which support the organization transition towards environmental responsibility and adopting green ICT. According to the participants, the study has given an opportunity to get insight to the maturity of the organization related to green ICT and guidelines are considered as a relevant when working with strategic priorities and future road maps within the organization. Implementing the guidelines into practice, is believed to need follow-up and extensive communication within the organization to increase generic awareness. Especially there is a need to ensure that the knowledge of the issue reaches and is understandable among the employees who are relevant for making the guidelines utilized and actionable. In addition, the participants see that the foundational nature of the guidelines could be utilized in discussions or workshops with the suppliers. The perspectives of the guidelines could be used in these situations, and it could be used as an opportunity to find future objectives for knowledge sharing in terms of environmental sustainability with the suppliers.

Extendibility as a theme describes the view that utilizing the guidelines also in the other areas than for which it was originally designed is possible. The guidelines can have potential to support development of other areas of sourcing towards environmental responsibility, and in particularly guideline 1 is seen to be beneficial when considering the entire ICT organization. These views are reflected in the example (12).

> (12) I think we can use it in terms of ICT equipment but as it is structured as it is, it is much easier to think that how we can utilize it. For example, although the guidelines are not covering the software purchasing we have now a framework that we can use and adapt (Workshop three 27.3.2024.)

Third theme identified from the final workshop is the suitability of research method. Participants reflected that the action design research method has been a suitable method to respond to the research problem and the objectives set for the study. The principles of ADR at the different stages were identified as having been implemented successfully during the development process. One of the participants reflected previous experience on action design-oriented research and acknowledged that it was interesting to notice that in context of this study the method worked well, and workshops were successful ways-of-working. Reflecting to the starting point of the study, participants can see that knowledge related to green ICT has increased, and various lessons learned have emerged among number of participants. The applicability of the lessons learned through the exercises, discussions, and guidelines developed in the workshops is seen as both possible and vital in other ICT areas of the case organization.

At the end of the workshop, it was decided that the formalization of learning from design process and the sharing of results will be continued in the case organization. The results of the study will be added to the company’s thesis database and the study results will be communicated through internal communication channels. This ensures the sharing and accessibility of information among relevant stakeholders and practitioners within the case organization.

4.4 Description of the artifact

This part of the study presents the artifact which contains four guidelines. The design of the guidelines is based on theoretical findings and the design development process in the case organization with the practitioners. The guidelines have formed a whole, combining the researcher's observations of the theoretical findings and the workshop participants' knowledge, perspectives, and observations of practice.

Guideline *Implement green ICT ideology and culture*, contains mechanisms through which the case organization can build the premise for greener business practices and increase generic ability to integrate environmental sustainability in their policies (Table 10.). Principle of this guideline is described as green ICT. This is consistent with the view that practicing increased environmental commitment and adopting a green culture increases the likelihood of adopting environmentally friendly behaviors (Hair et al., 2023). The mechanisms applied to the guideline are divided into six: 1) drivers and locus of motivation 2) compliance to responsible business conduct, 3) cultural changes, 4) knowledge capabilities, 5) impact mapping, and 6) optimized needs.

To shift towards the greener ICT operations, green ICT as an approach should be integrated to regular operations (Deloitte, 2023). In the premise of adopting green ideology, organization must be aware of the drivers coming from different sources that influence their motivation for adopting green ICT (Molla, 2009; Hankel et al., 2019; Radu, 2016). One of the drivers that impact the adoption of green ICT is the cultural and attitudinal changes, which has been acknowledged in the prior studies (Hankel et al., 2019) and by the practitioners who participated the design of the artifact. Culture and attitudes have a relation to knowledge capabilities, which is consistent with Hair and others (2023) argument, that results from environmental behavior can be changed to value and strategic resources when adopting the culture in which the environmental consideration and care is involved. When acknowledging the green ICT as a strategic priority, it can be seen to correlate with strengthened competitiveness, ensure compliance with sustainability regulations and excellence for stakeholders (Deloitte, 2023). Similarly, Weina and Yanling

(2022) have found that knowledge management activities correlate with the development of a sustainable business environment, environmental awareness, and the use of green technologies. Building a strong organizational culture, based on the pursuit of greening and quality improvement, requires raising awareness among employees about environmental initiatives that are both cost-efficient and eco-friendly (Fok et al., 2022). Hair and others (2023, p. 647) in addition address, that as the environmental challenges are a global issue, to strengthen the environmental behavior within the organization, managers need to "[--] value green resources as strategic assets and align them with national and international initiative [--]." Likewise, Fok and others (2022) concludes a willingness to improve economic, social, and environmental performance, requires managers to implement both, green and quality improvement practices, and mutually promote supportive and innovative culture within the organization. Such efforts were also noted among the practitioners, as they believe that the shift towards environmental sustainability needs to have the support from the top management, but it is more than positive if proactive efforts arise from the various levels of the organizations.

Impact mapping mechanism encourages to assess the current state of the organization in terms of green ICT by analyzing the level of sustainability in different areas, identifying both already existing practices that have a positive environmental impact and potential areas for improvement (Ning & Khuntia, 2023; ITU, 2023). This is justified by the requirement of company-wide due diligence and investigating business relationship to the adverse impact of company's operations, products, and services (Organization for Economic Co-operation and Development, 2018). By assessing the reach and richness ICT sustainability, the collected data can be used to get a comprehensive overview on the current state of green ICT maturity (Molla, 2008). When increasing the knowledge, it can be possible to determine the contribution level and further build a governance model around green ICT (SustainableIT.org, 2023). For the governance model, it is essential to ensure consistency with existing and forthcoming directives on responsible business conduct and due diligence (Council of European Union, 2023). This was acknowledged during the design development process by the practitioners, as shifting to greener direction requires keeping track on the impact to the sustainability that has already been done and identifying areas which lack on green practices and policies.

Optimized needs refer to an environmentally conscious approach to asset management: optimizing assets in ICT, not only can have positive impacts on costs, but also on the environment (McKinsey & Company, 2022). Evaluating and prioritizing the adoption of environmentally responsibility products as substitutes for existing assets is recommended and noted among practitioners of case organization. As an example, practitioners from the case organization noted that replacing the PCs of externals with virtual desktops can be potential activity to foster environmental sustainability in IT.

Table 10. Guideline 1: Adopt green ICT ideology and culture.

Description / Aim	To allow the organization (users) to implement sustainability considerations into development and management of ICT operations, to define the level of contribution, to build an environmentally sustainable ICT operating model, considering the requirements coming from different sources and shift to greener business culture (aim).
Context	Green ICT requires governance of environmentally sustainable ICT operating model, the presence of actors that see the benefit of operational sustainability and addresses operational environmentally sustainability gaps, and compliance to existing regulation.
Mechanism	▪ **Drivers and locus of motivation:** Clarify the underlying drivers (Hankel et al, 2019) and identify the locus of motivation (Molla, 2009). ▪ **Compliance to responsible business conduct:** Ensure compliance with responsible business practices by complying with existing and forthcoming directives. Consider due diligence in business operations, decision-making and implementation to reduce the risk of preventing the conduct of responsible business (Council of the European Union, 2023). ▪ **Cultural changes:** Change the culture and attitudes to acknowledgement of sustainable value of ICT through a leadership that supports bottom-up enthusiasm and actions toward sustainability (Hankel et al., 2019). ▪ **Knowledge capabilities:** Continuously increase knowledge capabilities of economic, environmental, and social concerns, and value green resources as strategic assets (Hair et al., 2023; Weina & Yanling, 2022). Prefer environmental and strategic initiatives in ICT which focus on cost-efficiency and eco-

	friendliness and share the information with the employees to strengthen the green culture (Fok et al., 2022). ▪ **Impact mapping:** Assess and pay attention to the reach (sourcing, operations, and end-of-life management) and richness (policies, practices, and technologies & systems) of green ICT within the organization (Molla, 2008). Proactively measure and collect data (track-recording) on the impact of operations in different areas, assess the data and define development targets to comply with responsible business conduct (Ning & Khuntia, 2023; ITU, 2023; Organization for Economic Co-operation and Development, 2018). Further determine the contribution level and build a governance/operating model for green ICT (Capgemini Research Institute, 2021; SustainableIT.org, 2023). ▪ **Optimized needs:** Consider the optimized number of the required IT assets to benefit from optimized costs by reducing the total number of assets in use (McKinsey & Company, 2022).
Rationale	- Business must be based on activities that contribute to improving, maintaining, and restoring a sustainable society (regenerative nature of business) (Hion, 2024). - Integrating sustainable concepts to the business models requires change from the traditional economic model to a model which prioritizes social and environmental aspects (Appiah et al., 2023).

Emphasize goals set by the company guideline highlight the importance of guiding the supplier selection to align with the organizational policies and targets (Table 11.). It guides the organization to consider the objectives of that are aimed to achieve through supplier's sustainability assessment and expected results from it. The principle of this guideline is described as principle of alignment. The mechanisms applied to the guideline are divided into four: 1) alignment of sourcing with sustainability objectives, 2) proactive practices, 3) mutual participation and cooperation, and 6) product certification and verified standards.

It is worth noting that purchasing decisions affect the organization, but also the whole economy, environment, and society (ISO, 2017) which is why the sourcing needs to be linked to organizations' sustainability objectives and ensure supplier's compliance to them. Gartner Inc. predicts that by 2026, sourcing will be increasingly required to operate at a consistent level of environmental performance and integrate sustainability requirements into the management of sourcing, contracts, and suppliers (Stamford, 2023). Gartner experts also highlight the identified correlation between sustainable sourcing activities and the reduction of the environmental impact of technology. Given this, the guidelines emphasize the importance to align sourcing activities and suppliers with sustainable environmental responsibility and organization's sustainability targets. Thus, the organization is responsible for selecting their approach how they seek to engage the supplier and clearly communicating its environmental responsibility policies and expectations to suppliers, and thus proactively requesting visibility and evidence of suppliers' environmental performance (Farsan et al., 2018). This argues in favor of a mechanism of proactive practices, which was also observed in practice during the development process. The organization can influence the environmental performance of suppliers, require transparency and alignment with their targets when sustainability requirements are set for suppliers. Suppliers' transparency can support achieving organizations sustainability targets (Capgemini Research Institute, 2021). While the organization takes responsibility on their value chain, it can be used as an incentive to influence the suppliers to do so (Freitag et al., 2020). According to Freitag and others (2020) this kind of activity can create a snowball effect in the economy.

Mechanism, mutual participation, and cooperation is linked to the idea of mutual benefits from environmental responsibility. Previous studies have found a link between sustainable sourcing and sustainable value: sustainable sourcing delivers sustainable value to supply chain stakeholders, as well as mutual benefits to suppliers and customers (Boruchowitch & Fritz, 2022). Suppliers can learn from their customers, learn to adapt to its corporate responsibility clauses and supplier selection criteria. It is acknowledged that transfer of knowledge can improve the collaboration and lead to improved performance outcomes (Whitehead et al., 2019). Boruchowitch and Fritz (2022) see that this way, suppliers can improve their sustainability performance, remain competitive and maintain their market share, and the buyer's environmental impact can be reduced. The impact goes even further, as more sustainable offerings come to the market, competitors will have to adapt to these offerings, and thereby market environment can shift to more sustainable and positive direction (Boruchowitch & Fritz, 2022). To make sure that the supplier is capable to provide, and the organizations selects environmentally friendly devices from the supplier, requesting certificates or third-party verified standards from the suppliers can support the decision-making (IEEE SA, 2021). Standards can ease the selection of supplier and purchasing of products that reflect environmental and social responsibility (IEEE, 2020). Organization needs to determine which standards or certificates it would require the supplier to have and communicate these expectations to the potential suppliers.

Table 11. Guideline 2: Emphasize the goals set by the company.

Description / Aim	To allow organization and sourcing experts (users) to align their sourcing processes, policies, and validation of suppliers to specified sustainability targets and incorporates environmental sustainability into sourcing (aim).
Context	Ensuring alignment of potential ICT suppliers with organization's environmental sustainability related strategic priorities, values and targets and cooperate with selected supplier to leverage the common knowledge capabilities on the environmental issues.
Mechanism	▪ **Alignment of sourcing with sustainability targets:** Make sure that the sourcing is aligned with organizational sustainability policies and targets (ISO, 2017) and the supplier is consistent, aligned and engaged with organization's sustainability performance expectations (Stamford, 2023). ▪ **Proactive practices:** Use proactive influence to engage supplier with organization's sustainability goal, clearly communicate the environmental policy and sustainable sourcing policy, and criteria used for evaluation/decision-making to the suppliers (Farsan, 2018). Seek to get visibility to supplier's sustainability practices and request information about environmental performance to increase transparency (Capgemini Research Institute, 2021). ▪ **Mutual participation and cooperation:** Prioritize suppliers that can work to mutual benefit. Foster open communication and collaboration with the supplier of available capabilities, innovative solutions, and opportunities to leverage suppliers' knowledge capabilities and contribute achieving sustainability goals (Boruchowitch & Fritz, 2022). ▪ **Product certification and verified standards:** Determine the required certifications or third-party verified standards which organization expects the

	supplier to have, such as related to eco-design or energy-efficiency (IEEE SA, 2021).
Rationale	- Building strong and long-term relationship with supplier has relation to sustainable practices (Taherdoost & Brard, 2019). - There is a shared responsibility for bearing and reducing the environmental burden of ICT between producers and users (Radu, 2016). - Standards can support achieving sustainability in all dimensions economic, environmental, and social, as they guide the actors to integrate sustainability into their operations and increase transparency (IEEE SA, 2021; European Commission, n.d.a).

Select environmentally friendly devices, and *Foster circularity and extend useful lifetime of equipment* are guidelines specified to relate the consideration and evaluation of supplier's environmental responsibility to the whole lifecycle of the ICT equipment and circular economy performance. Mechanisms applied into the guidelines are aimed to support the definition of requirements, list of criteria, and expectations that supplier is expected to meet. Suggested mechanisms in these guidelines also contain potential question that the organization can use and provide to the suppliers.

Select environmentally friendly equipment specifies the aspects that organization should consider while making purchasing decisions of devices and guaranteeing supplier's environmental conscious activities in dimensions of design, production, packaging, transportation, and energy-efficiency (Table 12.). Principle within the guideline is principle of environmental sustainability. The mechanisms applied to the guideline are divided into five: 1) design for recycling, 2) sustainability in production, 3) low transport emissions, 4) ecological packaging, and 5) adoption of energy-efficient equipment. The mechanisms aim for supporting the selection of devices of which are designed to minimize the e-waste, which is one of the most challenging and fastest growing waste streams in the world (Shittu et al., 2021; Tian et al., 2022). Design for recycling and ecological packaging as mechanisms aims to consider suppliers practices and contribution to the core idea in circular economy: designing products for reuse (Ellen MacArthur Foundation, 2013). From a circular economy perspective, designing products and packaging to be recyclable, it is seen to influence end-of-life behavior already at the design stage (Löw et al., 2021). In addition, selection, anticipation, and comparison of transport means which cause minimal emission should be considered as transport together with production and disposal form the three-fourths emissions of end-use devices (McKinsey & Company, 2022). What comes the production, it is recommended to assess the supplier's sustainability performance, policies, and solutions to the environmental impact of production (TIEKE, 2022). This is relevant as most GHG emissions from end-user devices are generated during production (Bieser et al., 2023). In addition, the use phase also has a reflective effect on the emissions generated, so by choosing energy-efficient equipment, a contribution can be made to environmental sustainability (Ministry of Transport and Communication, 2021; European Commission, 2021, McKinsey & Company, 2022; Zimmer, 2016).

Table 12. Guideline 3: Select environmentally friendly devices.

Description / Aim	To allow organization and sourcing experts (user) to select an ICT equipment for which the supplier has considered the different lifecycle environmental impacts (aim).
Context	When expecting the lowest amount of emissions throughout the lifecycle of the equipment, each phase of the lifecycle needs to be taken into account.
Mechanism	▪ **Design for recycling:** Assess suppliers design for recycling means and performance: recycled or refurbished material and parts used in the equipment, amount of recycled raw materials used in the equipment, use of hazardous substances (European Commission, 2021; TIEKE, 2022). *Is the product designed to minimize e-waste? How much recycled or refurbished material and parts is used in the equipment? What is amount of recycled raw materials used in the equipment? Is the product free from hazardous substances?* ▪ **Sustainability in production:** Production principles from the view of sustainability; energy source and innovative manufacturing solutions (TIEKE, 2022). *Is the energy used in production from a renewable source? How do the innovations used in production reflect environmental friendliness?*

	▪ **Ecological packaging:** Prefer packaging options that is designed to be recyclable and cause minimal impact to the environment (IEEE, 2020). *Is packaging designed to minimize waste, made from recycled material and is recyclable? Will the packaging and packaging material be recovered/returned for reuse?* ▪ **Low transportation emissions:** Prefer transport options which cause low emissions to the environmental (anticipate and compare options) (McKinsey & Company, 2022). *How have you contributed to minimize emissions from the transportation?* ▪ **Adoption of energy-efficient devices:** Strengthen attention to energy aspects and promote use of energy-efficient solutions (Ministry of Transport and Communication, 2021; European Commission, 2021, McKinsey & Company, 2022; Zimmer, 2016). *Which features indicate the energy efficiency of the product?*
Rationale	- Minimization of e-waste, maximizing the use of energy-efficient equipment and equipment recyclability are levers to impact environmental sustainability (ITU, 2023). - As an approach to indirectly impact and address the environmental impacts is the sourcing of energy-efficient designs/equipment (European Commission, 2021).

Foster circularity and extend useful lifetime of equipment guideline consist of mechanisms to ensure sustainable working practices through increasing the equipment lifespan and making conscious, environmental aware, decisions in the end-of-life phase (Table 13.). It promotes the circular economy approach similarly as the guideline 3 but specifies the assessment more to supplier operative practices and organizations contribution to the useful life of the device and its extension. The principle of the guideline is described as principle of closed loop and longevity. The mechanisms applied to the guideline are divided into four: 1) assess impact of prolonging the lifecycle, 2) use of refurbished devices, 3) ensure reliability and durability, and 4) environmentally aware end-of-life management. These mechanisms aim to increase the recycle-reuse-reduce-repair - thinking (Hion, 2024). The environmental impact during use is proportional to the length of the useful life of the equipment (Hilty et al., 2008). Hilty and others (2008) demonstrate that if the equipment can be used for six years instead of three years, the number of operational units of the equipment doubles and the impact of production on operational units is cut by half. Thereby, critically examining supplier's estimates on the replacement timelines and leasing cycles should be assessed to ensure maximized lifespan of the devices, so that the probability of unexpected operational issues would not increase (TIEKE, 2022).

To contribute to the longevity of the devices, one lever is to consider purchasing of the refurbished equipment, and thus participate promoting the equipment longevity (European Commission, 2021; TIEKE, 2022). Secondly, reliability and durability are characteristics that the devices are is expected to meet as they have the relation to operational efficiency, and thus to employee satisfaction. It is recommended to consider have an asset lifecycle management model to get visibility on the condition of the devices to minimize operational problems and costly breakdown (Flinders, 2023). It is noted that software that is used to promote predictive maintenance, can reduce 35-50% of the downtime and increase 20-40% of the asset lifespan (Gulvin, 2023). In addition, it must be ensured that the supplier is capable of repairing the equipment during its service life, for example through the availability of spare parts (European Commission, 2021).

As disposal of the devices is considered to have a linkage to significant environmental impacts (Capgemini Research Institute, 2021), the consideration and planning of environmentally sustainable end-of-life management is suggested. One of the challenges related to disposal is the low collection and recycling rates (Eerola et al., 2021) which is why the incorporation of practicalities that support sustainable management of material flows, return of the resources and handling of e-waste should be in place. Investigation of suppliers' end-of-life phase practicalities and the performance is an important lever to support circular economy (European Commission, 2021).

Table 13. Guideline 4: Foster circularity and extend useful lifetime of equipment.

Description / Aim	To allow organization and sourcing experts (user) to integrate circularity into sourcing practices by ensuring the optimized and maximized device life span, and environmentally aware end-of-life management policies (aim).
Context	Aiming for circularity requires assessment of the whole lifecycle of the equipment to support sustainable material flow and resource recovery, and planning of the end-of-life management practices.
Mechanism	▪ **Impact assessment of prolonging the lifecycle:** Evaluate the impacts and benefits of extending the lifecycle of assets and optimize replacement/leasing cycles to maximize the return of investment (Capgemini Research Institute; SustainableIT.org, 2023; TIEKE, 2022). *What is the length of the leasing/replacement cycle that is both environmentally sustainable and consistent with the expected level of performance?* ▪ **Use of refurbished equipment:** Evaluate the possibility to procure refurbished and remanufactured equipment (European Commission, 2021; TIEKE, 2022). *Is it possible to buy refurbished/remanufactured equipment?* ▪ **Reliability and durability**: Add resources to economic activities such as use of analytics tool for predictive maintenance and repair services to get information about the equipment performance (Gulvin, 2023). Guarantee the repairability and durability of the equipment by verifying the availability of spare parts and frequent software updates from the supplier (European Commission, 2021) *How is the durability and longevity of the equipment ensured and managed?* • **Environmentally aware end-of-life management:** Assess the level of responsible, proper, and safe equipment end-of-life management practices such as disposal and recycling methods of the supplier and comply these with organizational practices to minimize the generated e-waste (Capgemini Research Institute, 2021; European Commission, 2021; SustainableIT.org, 2023).

	What are the end-of-life management practices to ensure responsible recycling, disposal, recovery of the resources and sustainable material flow?
Rationale	- The purchaser has opportunity to impact circular economy and recycling by setting requirements for the suppliers (TIEKE, 2022). - Changed approach from traditional liner economic model to circular economy fosters the sustainability (Ali & Shirazi, 2023). - Consideration of whole lifecycle of the equipment is considered as a defensive measure to reduce ICT equipment related emissions and waste (McKinsey & Company, 2022; Welz & Stuermer, 2020).

4.5 Evaluation of artifact and formalization of learning

The aim of developing the guidelines was to respond to the case organization's need to raise awareness of the environmental impact of ICT operations, to identify areas of ICT operations where it would be both possible and relevant to promote environmentally responsible behavior, and to identify potential levers to achieve this. By increasing this kind of understanding, the case organization as an internal ICT function could contribute to an enterprise-wide vision of sustainability and decarbonization. The initial focus was set to examine the aspects of sourced ICT equipment and selection of ICT equipment suppliers. The expectation was that by incorporating environmental sustainability into this context and creating guidelines for it, it could support environmentally responsible decision-making, creation of requirements and expectations for the suppliers, increase environmentally conscious behavior, and reduce the environmental burden of ICT equipment. The rationale behind designing the guidelines is to provoke the organization to critically evaluate its policies, decisions, and objectives to comply with the environmental sustainability in terms of ICT. The guidelines were evaluated in terms of validity and utility and compared against the initial objectives together with the case organization representatives. The evaluation was done continuously during the design development process.

Firstly, the guidelines support the ability to create the premise for responsible and environmentally conscious business conduct. From the view of the validity, it was found that the guidelines and the design development process itself has increased generic knowledge of green ICT, ICT's environmental sustainability and provided a space for discussion. The guide itself is seen as having a ground building impact and works as an example case to initiate development of environmental responsible ICT operation, policies, and practices in the case organization in the future. As the case organization is part of a company that is not in the ICT sector, and its sustainability goals focuses mostly on company's core products, a different perspective needs to be taken on the carbon footprint of ICT. To contribute to enterprise-wide sustainability targets, it is required from the case organization to proactively gather an understanding of the carbon footprint of their activities and keep-track on current actions taken to promote environmental responsibility to determine the required level of contribution, and thus set targets for action. During the process of designing the guidelines, it was identified that a significant factor in achieving this is the attitudes, interest, and willingness of those working in the organization to promote sustainability and environmentally responsible actions.

To support these considerations, guideline 1 was designed to collect mechanisms to increase the awareness of how an ICT function can start adopting green ICT approach and commit to responsible and environmental conscious business conduct. Guideline increases the knowledge on mechanisms that can support creating conditions for responsible and environmental business conduct, setting up a greener business models, and evaluating the required contribution level. It can be concluded that it requires the following six levers. Firstly, understanding the drivers and locus of motivation behind adopting green ICT. Secondly, commitment to existing and upcoming directives and thus endorse due-diligence operations. Thirdly, shifting the organization culture and attitudes toward acknowledgement of value from green ICT. Fourthly, strengthening the knowledge capabilities on ICT's role in sustainable development, and fifthly mapping the environmental impacts of their operations, identify areas for development, and building an operating model to contribute for sustainability. And lastly, ensure that the asset needs of the organization are defined with attention to environmental sustainability. These levers are seen to have a positive effect on the case organization's ability to contribute to enterprise-wide sustainability goals and visions.

Secondly, the guidelines increase environmental sustainability considerations in the selection of ICT equipment suppliers and increase the environmental sustainability in sourced ICT equipment. The guidelines present aspects of the life cycle of the ICT equipment, that by considering and setting requirements on them, can be impacted to the reduction of adverse impact of the equipment, and thus scope 3 emissions, which are considered in the context of this study in terms of GHG emissions from sourced ICT equipment. Guideline 2 emphasizes the aim to align sourcing practices and policies to environmental sustainability. It specifies the mechanism to achieve this which are defining and communicating requirements to suppliers, collaborating, and proactively influencing to harmonize and ensure suppliers' environmentally responsible behavior with them. It can be assumed, that the clearer the organization's understands the environmental impact of ICT and has specified targets around it, the more consciously it can set requirements for the suppliers. Thereby, the usage of guideline 1 together with the guideline 2 can be considered inseparable. Although compared to the ability of equipment suppliers and purchasers to reduce the environmental load of equipment, equipment suppliers here have a greater ability to influence as they are primarily responsible for the equipment lifecycle stages such as design and manufacture of the equipment. This makes it even more significant that purchasers demonstrate their environmental awareness and, through their requirements, seek to influence suppliers' commitment to responsible actions. This can increase the contribution of the supplier to environmental responsibility and reflect the customer's efforts to do the same. In an example situation where the customer demands things X and Y and has pointed out that they affect decision-making when selecting a supplier from the potential candidates, it can be assumed that the supplier strives for compliance.

The mechanisms within the guidelines 3 and 4 are designed to consider the most significant aspects of ICT equipment lifecycle in terms of environmental sustainability, establish contribution to circular economy which emphasizes the extension of the lifecycle and removal or minimization of e-waste. Guideline 3 highlights the design and production sustainability, packaging and transportation, and lifecycle energy-efficiency. Guideline 4 wideness the aspects into circularity which considers the device longevity, use of refurbished devices, durability and reliability, and environmental responsible end-of-life management. Mentioned aspects should be taken into consideration when selecting the supplier, and setting up a list of requirements for them to ensure that the sourced ICT equipment that the supplier provides can be considered environmentally sustainable. In terms of reducing the environmental burden of the ICT equipment, the guidelines recommend preferring suppliers which have considered the whole lifecycle of the equipment with environmental sustainability as one of the priorities and are able to give proven information about it.

A holistic assessment of the validity of the guidelines and whether they work as intended shows that once the guidelines have been put together, it will be easier in future supplier selection processes to implement environmental responsibility in decision making. Guidelines can support setting up a discussion, and identifying important sustainability variables that can be transformed into questionnaire or list of criteria that supplier is requested to respond. Mechanisms aims to also establish the aspects that could be brought up when evaluating suppliers' environmental performance, comparing the performance to others, and identifying which of the supplier's has the most competence to support organization's environmentally sustainability and decrease the environmental burden of sourced ICT. However, the guideline does not take a stand on the concrete measures or metrics of how to compare suppliers.

It was also acknowledged throughout the evaluation, that the guidelines could be used when planning and setting up future expectations for the selected suppliers. This supports the utility the guidelines. The usage of the guidelines does not have to be limited only to the supplier selection process, but it can be leveraged to the post activities, such as defining supplier development targets in terms of environmental sustainability, monitoring the fulfilment and development of supplier's responsibility, and evaluating the impact of the implementation of environmentally responsible activities in a long term. In addition, it can be concluded that the design principles of the guideline can be used in other action design or development situations. Principles are general in nature which increases their utility. Green ICT as a principle fosters the ideology and the cultural mindset that strives to a greener business practice. Principle of the alignment can be considered as related to aligning the stakeholders in various situations to organizational objectives and activities for mutual benefit. Principle of environmental sustainability and closed loop and longevity, on the other hand reflect the commitment to consider environmental aspects and contribution to circular economy.

5 Discussion and concluding remarks

This study designed guidelines for responsible and environmentally sustainable ICT equipment supplier selection for the case organization. The aim of the study was to support the case organization taking first steps in shifting their operations into greener direction and examine the role of ICT service organization in contributing to environmental sustainability. The core idea of the guidelines is to provide guidance on how organizations who source, purchase or lease ICT equipment can take environmental responsibility into account and adopt green ICT means. Guidelines consist of aspect of ICT and suppliers' operations that should be considered when choosing the supplier to reduce emissions from scope 3 for purchased equipment, and contribute to responsible, environmental conscious business conduct. To create the guidelines and respond to the organizational need, two research questions were posed: what are the aspects that should be considered in supplier selection to promote environmental sustainability and reduce the environmental burden associated with the sourced ICT equipment, and how does incorporating environmental sustainability in the supplier selection contribute to sustainability efforts in the case organization. To respond the research questions set, the study was carried out as action design research. The design of the guidelines and continuous reflection on learning outcomes were carried out in the organization context together with the case organization practitioners and expert during the workshops. A total of three workshops were held during the design development process.

The study approached the research questions first by reviewing the theoretical insight within the topic are of ICT's role in environmental challenges, sustainable sourcing and supplier selection, and environmental sustainability in ICT sourcing. The impacts of ICT on responsible business and sustainable development are seen to be twofold, because despite the potential of ICT to reduce emissions in other sectors, the ICT sector's own emissions are growing (Allianz Research, 2023; Hion, 2024; Latif et al., 2023; Santarius & Wagner, 2023). A significant part of the emissions is generated by ICT equipment and their life cycle emissions (Bieser et al., 2023; McKinsey & Company, 2022). These emissions are largely generated from manufacturing, use and disposal of the equipment

(Bieser et al., 2023; Capgemini Research Institute, 2021). Energy consumption during production (Bieser et al., 2023), increased application requirements (TIEKE, 2022), and the growth of electronic waste into one of the world's largest waste sources (Tian et al., 2022) reflects a reasons for high amount of emissions and increased carbon footprint of ICT.

Only recently, the focus has been more on promoting the environmental sustainability in ICT (Santarius & Wagner, 2023). Previous studies have made observations that as the adverse impacts of ICT has been more widely acknowledged, the requirements for organizations to review their business principles regarding ICT has increased (Appia et al., 2023; Chou et al., 2023; Council of the European Union, 2023; Taherdoost & Brard, 2019) and environmental sustainability has leveraged its position into top 10 business priorities (Stamford, 2023). However, despite the increased carbon footprint of ICT and requirements, in most organizations there is no strategy for sustainable ICT or it is disconnected from the enterprise-wide sustainability strategy (Capgemini Research Institute, 2021). The reduction of adverse environmental impacts is seen as positively correlated with measures such as considering emissions throughout the life cycle of the device, commitment to circular economy principles such as minimizing e-waste and extending the lifespan of the devices and the ability and willingness of organizations to adopt greener practices and policies (Appiah et al., 2023; Shittu et al., 2021; SustainableIT.org, 2023, World Economic Forum, 2019). This is also reflected in actions taken by public actors, such as the ICT sector's environmental strategy and guide for public procurement published by the Finnish Ministry of Transport and Communications, and the European Commission's proposal of the Sustainability Due Diligence Directive, and a voluntary Green Public Procurement tool designed for use by EU member states, which all highlighting the need to transform traditional business models into ones that are more in line with the principles of circular economy (European Union, 2022; Ministry of Transport and Communications, 2020).

As the adverse environmental impacts of sourced ICT equipment are partly contributed by the company and caused by a business relationship, according to due diligent responsibility, the company or an organization must prevent the potential impact or use leverage to influence the factor causing the effect (Kilsby & Puzniak-Holford, 2023; Organization for Economic Co-operation and Development, 2018). This creates the shared the responsibility for reducing ICT's adverse environmental impacts between device manufacturers, suppliers, and end-users (Radu, 2016). At the same time, this emphasizes that in a situation when even though the organization has not directly caused the emissions, they still have a responsibility to try to influence the factor that causes the adverse environmental impacts (Organization for Economic Co-operation and Development, 2018).

It has been estimated that organization's business with IT vendors who can demonstrate sustainability goals and schedules will grow over the coming years (Stamford, 2023). To reduce the environmental impacts of ICT equipment, changes in equipment sourcing and supplier selection toward environmental responsibility and sustainability is suggested to incorporate into sourcing processes (McKinsey & Company, 2022; SustainableIT.org, 2023; Welz & Stuermer, 2020). To adopt greener sourcing and green ICT levers, it is seen as crucial that environmental criteria is defined and included in supplier selection and decision-making strategy in ICT sourcing (Deloitte, 2023; Singh et al., 2024). Thus, this needs to be supported by prevailing culture within the organization, which places the goal of a greener ICT in a strategic and important position (Appiah et al., 2023; Hair et al., 2023). The first research question examined the aspect that should be considered in supplier selection, and it was discovered from the theoretical findings that these aspects should consider the requirements for green operations from various sources, environmental impacts of the different stages of the equipment life cycle, the principles of the circular economy, potential to influence suppliers to responsible and green business operations, and holistically integrating greener view into supplier selection process.

Theoretical findings have been utilized in the design and justification of the guidelines, but the key design inputs were collected in empirical part of the study which was carried out in the organization context trough the workshop sessions with experts from the case organization. The workshops were used to design the guidelines, and to assess how the study and action design affect the perception of the case organization about green ICT, and how the guidelines support their environmental sustainability efforts. The case organization representatives involved in the guidelines design development process found that as a practical contribution, the whole process has promoted the first steps in the development of their organization in a greener and more sustainable direction. Through the study, the case organization will take concrete steps to develop their operations into greener direction. The study has brought an understanding of the responsibility and potential of the ICT function to make a positive impact on environmental sustainability and the reduction of environmental burden of ICT. The existence of guidelines and the study as a whole is seen to support this, as the designed guidelines for supplier selection are considered as already as one step closer to greener operations. The study has encouraged and stimulated interest within the case organization to review future strategic priorities, cultural aspects, future plans and competence development. One of the most relevant findings is that the case organization feels that the step-by-step transition to a greener and more sustainable ICT organization will allow them to contribute to the enterprise-wide sustainability vision and goals.

Guidelines increase practical understanding of related relationship between supplier selection and environmental impact, and a social responsibility of the organization to make decisions that take environmental considerations into account, and to minimize risks that hinder the implementation of responsible business. Representatives from the case organization see that the guidelines can be useful not only during the supplier selection process, but also at a later stage when a supplier has been selected and there is a desire to set targets or expectations for the partnership period in terms of environmental responsibility. In response to the second research question, it can be concluded that the incorporating environmental sustainability in the supplier selection provides a good starting point for greening ICT activities within the case organization, enables promotion of function-level environmentally responsible business practices and ensures alignment of supplier selection process to organization's environmentally responsible objectives.

This study has contributed to the scientific literature by creating guidelines for responsible and environmentally sustainable ICT equipment supplier selection from the perspective of an ICT support organization. This study has aimed to fill the research gap presented in the introduction on the environmentally responsible actions of non-ICT sector organizations or functions to reduce the harmful effects of ICT. The study has brought a perspective to this through action design research by emphasizing the existence of responsibility and suggesting levers related to supplier selection. It is suggested through the designed guidelines that shifting culture and operating principles to a more environmentally sustainable direction, considering the perspectives related to environmental sustainability in the supplier selection process and applying environmental criteria into it, are concrete ways to adapt to this responsibility. The study has combined findings from previous research on environmental responsibility of organization (Appiah et al., 2023), adverse impacts of ICT (Freitag et al., 2021), relationship between sourcing decision and environmental impacts (Stamford, 2023), and environmental criteria in supplier selection (Deloitte, 2023; Zimmer, 2016), and adopted them into the designed guidelines.

The validity of the selected study methods was evaluated together with the case organization representatives. The method was seen to fit well with the generic working methods of the case organization, as typically their various development projects and processes follow iterative, agile-oriented steps. The continuous and iterative design development and knowledge sharing between the researcher and representatives of the case organization were seen as successful. It can thus be concluded that this study is in line with the findings of the scientific research community on the validity of action design research as a qualitative research method.

The limitations of this study relate to firstly to examining the sustainability only in terms of environmental sustainability. Previous research has shown that implementing all dimensions of sustainability into supplier selection and requirement criteria is significant (Schneider, 2012). This study was conducted in the context of environmental sustainability, so this identified constraint does not however limit the answers to the research questions asked, but nevertheless excludes the two dimensions that are significant in terms of sustainability. Secondly, the complexity of documenting unstructured material of the workshops may have affected the description of the design process and the correct description of the perspectives and comments presented by the participants in the workshops.

These limitations have been taken into consideration when assessing the reliability and validity of the study. Efforts have been made to ensure the reliability of the study by assessing the recommendation made by previous research of the means how reliability of the studies can be ensured and increased (Thoring et al., 2020). The reliability of the artifact, created in the context organization, is justified by the setting of research objectives together with the case organization representatives in the early research phase and by reflecting on these objectives during workshops. The role and contribution of representatives involved in the design development process have been presented and communicated. Triangulation of the study, diversity of methods and analysis of the data, has been supported through workshops and continuous reflection to lessons learned. Efforts has been made also to ensure the transparency of the study by describing the stages of the design process in a detail, so that the study is as understandable and reproducible as possible. Transparency is also enhanced by its publication to the case organization thesis library and through the university's thesis database.

As future research directions and managerial implications it is suggested that the usability of the guidelines could be tested by implementing them into the ICT supplier selection process. Guidelines could be used in the beginning of the selection process to support establishing environmental aspects into the selection process and determining list of criteria for potential suppliers. Testing the guidelines could be seen as relevant to ensure their usability and practicality. Furthermore, research on two other dimensions of sustainability, economic and social and creating guidelines which contain each of these could be seen valuable. Suggested research question could seek to address, which economic and social aspects should be considered along the environmental aspects in ICT equipment supplier selection to comply with the responsible business conduct and reduce the adverse impacts of ICT. Answering to the suggested research question could enable leveraging all three aspect of sustainability, economic, social, and environmental, and support the integration of sustainability into sourcing processes. To continue the adoption of green ICT and reduce the environmental impact of ICT in the case organization, it is proposed as a managerial implication to extend the evaluation of green ICT in various ICT areas. As a starting point the areas that previous studies have used to evaluate the maturity and readiness of green ICT in organization and IT departments can be considered (Deloitte, 2023; SustainableIT.org, 2023). The areas of ICT can relate to green coding, SaaS and cloud computing, data centers, network, cloud services, software and electronic services, and ICT governance. Suggested research question in this issue is set as, what is the level of green ICT maturity in the ICT function and does it meet the required level to ensure environmentally responsible business operations. This can support the understanding of the organization’s state on the green ICT maturity and thus strengthen the readiness to comply with the existing or upcoming requirements from the society. More holistically, it can leverage the knowledge of the areas where ICT support organization can contribute and support both enterprise-wide and global environmental sustainability goals and can increase the understanding of the impact it can have.

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