Silja Pöyhönen

GREEN IT PERSPECTIVE ON SUSTAINABLE SMART TOURISM DEVELOPMENT

UNIVERSITY OF JYVÄSKYLÄ
DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION SYSTEMS
2019

ABSTRACT

Pöyhönen, Silja
Green IT Perspective on Sustainable Smart Tourism Development
Jyväskylä: University of Jyväskylä, 2019, 92 p.
Information System Science, Master's Thesis
Supervisor: Makkonen, Pekka

Smart tourism is an advanced form of tourism generated by technological development, in which IT is used to support touristic activities. Smart technology is used to create, manage and to deliver intelligent touristic services. However, tourism is a conflicting field, as tourism generates a vast amount of negative environmental impacts. Since IT is a key part of the development of smart tourism, it is reasonable to examine smart tourism from the perspective of green IT. Green IT means sustainable and environmentally sound information technology. The objective of green IT is to reduce negative environmental impacts by using sustainable technology and developing technological solutions that help in reducing the negative environmental impacts of other processes. As tourism is a major source of income around the world, it is important that it is developed in a sustainable manner. This study explored how green IT principles are incorporated in Finnish smart tourism development by conducting a literature review and an empirical research. The results of the study found that green IT principles appear in Finnish smart tourism development mostly through attitudes, enabling impacts and systemic impacts. In all projects, environmental issues were regarded as an important part of the development of smart tourism and many enabling and systemic impacts were found in the study. Taking the direct impacts of IT into account was found to be at a weak state. At the strategic and governing level, environmental factors were found to be poorly regarded. Environmental factors are not included in strategies, policies and responsibilities regarding the development or use of ICT. The study produced new information on Finnish smart tourism development and on the state of its sustainability, as Finnish smart tourism development projects have not been studied before. The developed research framework was found to be suitable for studying the subject and can be utilized in further studies that aim to examine the sustainability of an entity. The framework can also be used as a tool in developing smart tourism, as the themes of the framework form a sustainable whole.

Keywords: smart tourism, smart tourism development, green IT, sustainability, sustainable tourism

TIIVISTELMÄ

Pöyhönen, Silja
Green IT Perspective on Sustainable Smart Tourism Development
Jyväskylä: Jyväskylän yliopisto, 2019, 92 s.
Tietojärjestelmätiede, pro gradu -tutkielma
Ohjaaja: Makkonen, Pekka

Älyturismi on teknologian kehityksen synnyttämä turismin muoto, jossa informaatioteknologiaa käytetään laajasti turismin tukena. Älyturismissa informaatioteknologiaa käytetään älykkäiden turistipalveluiden luomiseen, hallinnoimiseen sekä toimittamiseen. Turismi on kuitenkin ristiriitainen ala, sillä turismi aiheuttaa hyvin paljon negatiivisia ympäristövaikutuksia. Koska älyturismin kehityksessä informaatioteknologia on keskeisessä osassa, on järkevää tarkastella älyturismia vihreän informaatioteknologian näkökulmasta. Vihreällä IT:llä tarkoitetaan kestävää ja ympäristöystävällistä teknologiaa. Vihreän IT:n tavoitteena on vähentää negatiivisia ympäristövaikutuksia käyttämällä kestävää teknologiaa sekä kehittämällä teknologisia ratkaisuja, jotka auttavat vähentämään muiden prosessien negatiivisia ympäristövaikutuksia. Koska turismi on merkittävä tulonlähde ympäri maailman, on tärkeää, että sitä kehitetään kestävällä tavalla. Tässä tutkimuksessa selvitettiin kirjallisuuskatsauksen ja empiirisen tutkimuksen avulla, kuinka vihreän IT:n perusperiaatteet ovat mukana älyturismin kehityksessä Suomessa. Tutkimuksen tuloksista huomattiin, että vihreän IT:n perusperiaatteet näkyvät suomalaisessa älyturismin kehityksessä enimmäkseen asenteiden, IT:n mahdollistavien vaikutusten sekä IT:n systeemisten vaikutusten kautta. Ympäristöasioiden huomioon ottamista pidettiin tärkeänä osana älyturismin kehitystä kaikissa tutkituissa projekteissa. Tutkimuksessa löydettiin monia IT:n mahdollistavia sekä systeemisiä vaikutuksia. IT:n suoria vaikutuksia otettiin projekteissa huomioon heikosti. Strategisella sekä johtamisen tasolla ympäristöasioihin ei kiinnitetty huomiota tutkituissa projekteissa. Kestävyyttä ei ole sisällytetty tavoitteisiin, strategioihin ja käytänteisiin eikä rooleja ja vastuita ole määritelty ICT:n kestävän kehityksen seurannalle. Tutkimus tuotti uutta tietoa suomalaisesta älyturismin kehityksestä sekä sen kestävyyden tilasta, sillä suomalaisia älyturismin kehitykseen liittyviä projekteja ei ole aikaisemmin tutkittu. Tutkimusta varten rakennettu viitekehys todettiin sopivaksi aiheen tutkimiselle ja sitä voidaan hyödyntää jatkossa muissa tutkimuksissa, joissa on tarkoituksena tarkastella jonkun toimijan kestävyyden tilaa. Viitekehystä voidaan myös käyttää älyturismin kehityksen tukena, sillä viitekehyksen teemat muodostavat yhdessä kestävän kokonaisuuden.

Asiasanat: älyturismi, älyturismin kehitys, vihreä informaatioteknologia, kestävä kehitys, kestävä turismi

FIGURES

TABLES

TABLE OF CONTENTS

1 INTRODUCTION

Continuously increasing number of cities around the world strive towards smartness and desire to claim the title “smart city”. The present-day technological development offers new business opportunities to everyone and a remarkable chance to personalize services. Smart tourism is a fairly new tourism service concept born from the development of information technology. Smart destinations and their technologically enhanced tourism experiences offer a substantial stream of revenue for those who succeed in attracting smart tourism (Albino, Berardi, & Dangelico, 2015; Boes, Buhalis, & Inversini, 2016; Buhalis & Amaranggana, 2015; Gretzel, Sigala, Xiang, & Koo, 2015). The Finnish capital Helsinki was selected as the winner of EU’s inaugural European Capital of Smart Tourism competition (Good News from Finland, 2018). The smart tourism categories that were used in the evaluation were accessibility, sustainability, digitalization, cultural heritage and creativity. This piece of news confirms that Finland is in a leading role in smart tourism development which is not unexpected from the technologically developed country.

Tourism, be it traditional or smart, is a viable and important economic development strategy for many countries and cities (Harrill, 2004) but one must not forget that tourism has many negative impacts on the environment, cultural heritage and the local population (Pan et al., 2018). The natural environment of a place consists of many things: animals, plants, soil, water, air and people (May, 1991). Tourism poses a threat to all of these things. Structural impacts of tourism modify the landscape, soil and the natural habitat of animals. Air travel and traveling by cars have polluting effects that increase the amount of carbon dioxide in the atmosphere. The spreading of tourism has accelerated the already overwhelming loss of forestry and soil, polluted the water and air and forced cultures to change. (May, 1991; Pan et al., 2018.)

The world is more globally connected than ever. The amount of work-related travel is large, some actually travel as their job, and people have a craving to see the world. Restraining tourism does not seem to be an option and therefore one must find other means to decrease the negative impacts of tourism and to develop tourism sustainably. Since tourism is going “smart” and

technology has an increasing role in tourism, the green IT perspective seems a promising one. The basic thought behind green information technology is sustainability and sustainable development by creating environmentally sound technology and information systems that can be used in reducing negative environmental impacts (Murugesan, 2008). The green IT perspective, it's values and models are promising tools in developing smart tourism sustainably.

The development of smart tourism is problematic, as tourism itself generates many negative impacts on the environment and the information technology used in its development has also its own negative impacts. The purpose of this thesis is to examine the development of smart tourism from the perspective of green IT and to assess how sustainable Finnish smart tourism is by green IT principles. The research topic is very significant and current, as the development of information technology has led to an increasing use of technology in supporting tourism services worldwide and the environmental problems of our planet are concerning people more and more. There exists a large amount of research on green IT and some on smart tourism, but research that concentrates on the sustainability of smart tourism or on sustainability of smart tourism development is scarce. The amount of tourism (or smart tourism) is probably not decreasing, which is why it is very important that smart tourism development is regarded from a sustainable point of view. The research question of the thesis was defined as follows:

- How are green IT sustainability principles incorporated in Finnish smart tourism development and its ICT solutions?

In order to gain a deeper understanding of the research topic, the following supporting questions were also defined for the study:

- What is smart tourism and smart tourism development?
- Which technologies and ICT solutions are being used in smart tourism development?
- What are green IT and green IT sustainability principles?

The study began with a literature review. The literature was mainly collected through the Google Scholar search engine and the following databases: Academic Search Elite (EBSCO), Advanced Technologies & Aerospace database (ProQuest) and Association for Information Systems Electronic library. Some topical information was searched for in news articles. In addition, printed literature was searched from the database of Jyväskylä University Library. The following keywords and their combinations were used in searching the material: smart tourism, smart tourism destination, smart tourism development, green IT, green information technology, sustainable technology, green IT principles, green IT models, sustainable smart tourism and tourism and the environment. In addition, some material was also searched through the source references of key articles. Most of the material is literature from the field of IT. For the most

part, the materials used were articles but there were also some conference publications, books and news articles.

The empirical part of the study was performed by using a qualitative research method. The data collection was done by conducting semi-structured interviews that were based on a research framework created from the literature. The interviews were transcribed and analyzed using qualitative analysis. The analysis consisted of four phases: reading, categorizing, finding connections and reporting. In addition to qualitative reporting, quantitative reporting was used to facilitate the understanding of the research results.

In addition to the introduction, the thesis consists of 7 chapters. The second and the third chapter form the literature review. The second chapter defines the concept of smart tourism, presents the technological foundations of smart tourism, describes smart tourism destinations and their development and presents the impacts of tourism. The third chapter deals with green IT: the concept of green IT is explained, environmental impacts of IT are reported, green IT practices and approaches and benefits of green IT are explained, and the most used green IT frameworks are presented. The fourth chapter consists of a summary of the literature review and the development of the research framework for the empirical research. The fifth chapter presents the empirical research and its implementation. The sixth chapter presents the research results grouped according to the research framework. The seventh chapter consists of discussion where the relevance of the study and its results are discussed and the reliability, validity, generalization and limitations of the study are reviewed. The last chapter presents a summary and conclusions of the study as well as further research topics.

2 SMART TOURISM

This chapter focuses on smart tourism and its technological foundations. First, some demonstrative concepts and vocabulary are explained. This chapter explains the concept of smart tourism, presents its technologies and infrastructure, describes smart tourism destinations and their characteristics and then moves onto the environmental and sociocultural aspects of tourism.

2.1 Main concepts

Smart technology refers to technology operated on sensors, open data, exchange of information and big data (Gretzel, Sigala, et al., 2015). Harrison et al. (2010) define **smart** as "exploiting operational, near-real-time real-world data, integrating and sharing data, and using complex analytics, modelling, optimization and visualization to make better operational decisions". **Smart** is also defined as "the ability to quickly, flexibly and accurately understand and solve problems" (Li, Hu, Huang, & Duan, 2017a). According to Gretzel et al. (2015), **smartness** is not only the individual technological developments but rather the interconnection and synchronization of digital and physical. Buhalis & Amaranggana (2013) suggest that the concept "smartness" refers to complex technological infrastructures and "integration of ICT to improve processes and interconnect sub-systems".

Tourism "is a social, cultural and economic phenomenon which entails the movement of people to countries or places outside their usual environment for personal or business/professional purposes" (UNWTO, 2019). Harrill (2004) defines tourism as "all travel except commuting" that is combined of transportation, lodging, entertainment activities and exercises, land use, environment and social structure. Tourism can be divided further into subcategories, e.g. ecotourism, rural tourism, culture tourism, community tourism and wildlife tourism. (Pan et al., 2018).

Sustainability refers to "avoidance of the depletion of natural resources in order to maintain an ecological balance" (Oxford Living Dictionaries, 2019). **Sustainable development** refers to development where today's needs are met in a way that does not compromise the ability of future generations to meet their needs (Dao, Langella, & Carbo, 2011). A triple bottom line perspective on sustainability includes three elements: the natural environment, society and economic performance. Sustainability and sustainable development are not truly effective if one concentrates only on a single actor. For example, if a company aspires to the truly sustainable, its supply chains and other stakeholders must also operate in a sustainable manner. (Dao et al., 2011.)

Smart tourism contains all tourism related activities that are informed, supported and completed by smart technology (Gretzel, Sigala, et al., 2015). The term "smart tourism" appears in research to subscribe the adoption of ICT into the tourism field. The definition of smart tourism varies across the world but the current definitions share many fundamental aspects. Li et al. (2017) describe smart tourism as the use of new technologies on portable devices via the Internet to achieve information about tourist resources, tourist economy, actives, etc. The new technologies listed as an example are cloud computing, networking and big data. One core purpose of smart tourism is collecting, processing and exchanging tourism related data. The data is derived from tourists, physical infrastructure, organizational sources and social connectedness (Put-Van Den Beemt & Smith, n.d.). The gathered data enables companies and service providers to personalize tourism services. (Buhalis & Amaranggana, 2015; Gretzel, Sigala, et al., 2015.) The personalization of tourism services is said to improve the quality of services and the tourists' satisfaction (Buhalis & Amaranggana, 2015; Gretzel, Sigala, et al., 2015; Li et al., 2017a).

Gretzel, Sigala, et al. (2015) suggest that smart tourism can be sectioned into three components that are supported by ICT. These components are "smart experience", "smart business ecosystem" and "smart destination". In addition, there are three smart layers that span these components: an information layer for collecting data, an exchange layer that supports interconnectivity and a processing layer where the gathered data is analyzed, visualized and integrated. The components and layers of smart tourism are presented in

(modified from the original by Gretzel, Sigala, et al. (2015)).

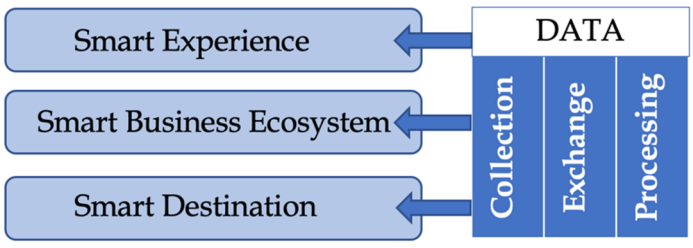

Figure 1. Components and layers of smart tourism (Gretzel, Sigala, et al., 2015)

Smart experience refers to the technologically enhanced tourism experiences that are created through personalization, context awareness and monitoring or data gathering (Buhalis & Amaranggana, 2015; Gretzel, Sigala, et al., 2015). The tourists are active participants in the creation of the smart experience: in addition to consuming, they create and enhance the data that is used as the basis of the experience by uploading pictures on social media, adding restaurants on Google Maps, by writing reviews on services etc. The tourists are not only consumers, but also active participants in the value co-creation process.

The smart business ecosystem is "a complex business ecosystem that creates and supports the exchange of touristic resources and the co-creation of the tourism experience" (Gretzel, Sigala, et al., 2015). In the smart business ecosystem the stakeholders are dynamically interconnected, the core business processes are digitalized and the organizations are agile. Buhalis & Amaranggana (2013) suggest that unusual amount of public-private collaboration is distinct in these ecosystems. In addition, since the tourist are value co-creators in these ecosystems, they can take on business or governance roles.

Smart destinations are special cases of smart cities. They are innovative tourist destinations that have a technologically advanced infrastructure that ensures the sustainable development of tourist areas. The smart destination and its surroundings interact with the visitor through ICT while gathering data on multitude of subjects. The factor that separates smart destinations from "traditional" destinations is the integration of ICT into the physical infrastructure of the destination. Smart destinations and their characteristics are presented in more detail in chapter 2.3.

Smart tourism uses smart technology to create, manage and to deliver intelligent touristic services through information sharing and value co-creation (Gretzel, Werthner, Koo, & Lamsfus, 2015). People are connected with technology and create financial, social and environmental affluence collaboratively (Boes et al., 2016). Economic and environmental sustainability are essential factors in smart tourism and are important for the viability of the smart tourism ecosystem (Boes et al., 2016; Buhalis & Amaranggana, 2015; Gretzel, Sigala, et al., 2015). According to Gretzel, Sigala, et al. (2015) smart tourism results in "convenient, safe, exciting and sustainable living spaces for both residents and tourist". In short, the goal of smart tourism is to offer enhances, high-value, meaningful and sustainable tourism experiences via a "digital ecosystem that provides technological resources and facilitates interactions within species and among species" (Gretzel, Werthner, et al., 2015).

From the tourist's perspective, smart tourism covers all the travel related activities that he/she does on his/her own portable device through various applications or programs over the Internet. This might involve booking flights and accommodation, using Uber, Airbnb or TripAdvisor, ordering different services, using a map application for navigation, making social media posts and writing and reading reviews on hotels, restaurants and museums. These are all tourism related activities that are supported by technology. Data gathering enables the service providers to personalize the offered services. For the tourist, this may

appear, for example, as offered choices that resemble his/her earlier choices. Smart tourism also covers many of the services and shared content that the tourist consumes in different destinations. Offers, services and information can be shared directly to the tourist's own device based on the location of the tourist.

The technology network supporting smart tourism consists of many different technologies, such as platforms and media, support services, travel technology and data companies, applications and websites and other technological components such as sensors, processors and software (Gretzel, Werthner, et al., 2015; Koo, Gretzel, Hunter, & Chung, 2015). In addition to the complex technological network, the smart tourism ecosystem relies on the residential infrastructure of the destination (Gretzel, Sigala, et al., 2015).

All in all, the concept of smart tourism is a combination of physical attributes, technology, networks, services, companies and human interaction. The principles of smart tourism are enhancing tourism experiences, improving the efficiency of resource management and increasing the destination's competitiveness with sustainable manner (Gretzel, Sigala, et al., 2015; Gretzel, Zhong, & Koo, 2016; Put-Van Den Beemt & Smith, n.d.). Since the developments and innovations in the field of ICT were adopted in the tourism industry, smart tourism is a rational progression from traditional tourism (Gretzel, Sigala, et al., 2015) and can be considered as an advanced form of tourism (Li et al., 2017a).

2.2 Technological foundations of Smart Tourism

Smart tourism is dependent upon tourists and therefore, smart tourism is present in the locations where tourists go. These smart tourism destinations are very often cities of different sizes. Since smart tourism destinations (more thoroughly addressed in chapter 2.3) are one form of smart cities, the technological foundation of smart tourism is based on the same technologies that are used in smart cities. In a smart tourism setting, technologies and information systems that supply tourists and service providers with relevant information are a key component. These smart information systems include for example decision support systems, recommender systems, independent agents searching and mining Internet sources, ambient intelligence and also systems that produce augmented realities (Gretzel, Sigala, et al., 2015). All these smart systems have three important purposes. First, they aim to anticipate user needs and to make intelligent suggestions and recommendations. Second, they are meant to enhance the tourists' experience at the site by providing rich information and personalized, interactive services. Third, they are meant to enable tourists to share their experiences on social networks which might guide others in making their travel decisions. (Gretzel, Sigala, et al., 2015.)

In smart tourism, technology is seen as an interconnected infrastructure of information systems, computing technologies, hardware, software, advanced analytics and network technologies (Gretzel, Sigala, et al., 2015; Li, Hu, Huang, & Duan, 2017b; Su et al., 2015). Mobile devices, since they accompany tourists

everywhere, are a very important part of the smart tourism technology network (Gretzel, Sigala, et al., 2015), as are other technological innovations that support mobile access, such as Cloud Computing and End-User Internet Service Systems (Buhalis & Amaranggana, 2013; Gretzel, Sigala, et al., 2015). The Cloud Computing services provide an easy way to access web platforms and data storages through networks, and the End-User Internet Service Systems are various applications that are supported by Could Computing and IoT (Buhalis & Amaranggana, 2013).

The integration of ICT into the physical infrastructure is one characteristic of smart tourism and its destinations. This can be manifested by sensors, iBeacon technology, IoT, QR codes and Near Field Communication (NFC) tags (Buhalis & Amaranggana, 2013; Gretzel, Sigala, et al., 2015; Harrison et al., 2010). Sensors can be used for many purposes: they can measure water and air temperatures, they can perceive the amount of people at a location or an event for security purposes and they can also be used for traffic monitoring (Buhalis & Amaranggana, 2015). The data gathered by the sensors is processed into accurate, real-time and meaningful information which is then provided to the service providers, tourists and locals through different systems and end-user services (Buhalis & Amaranggana, 2013).

Internet of Things (IoT) has a high potential in tourism services. The basic idea of IoT is objects that are able to communicate and cooperate with other objects to achieve common goals. The objects are connected to the Internet bringing the real world and the digital world together. Therefore, IoT "creates platforms that are able to transmit range types of data using a participatory sensing system". (Gretzel, Sigala, et al., 2015.) According to Gretel, Sigala, et al. (2015) the full potential of IoT is yet to be realized in tourism services but in the future the emergence of IoT will cause a shift towards always responsive and personalized services.

All these technological developments have enabled the collection, transfer and analysis of a large amount of data. Open Data and the data gathered from sensors, city elements, organizations, citizens and visitors provide real-time information that can be used for many purposes. Large data sets known as Big Data can be analyzed and then used for offering personalized services, that are customized to the user's preference at the right time (Buhalis & Amaranggana, 2015). The technological foundation of smart tourism is multidimensional and supports interaction with the physical environment and the community.

2.3 Smart Tourism Destinations

In this chapter, Smart Tourism Destinations (later referred to as smart destinations) are presented. The characteristics of smart destinations are reviewed, some examples of current smart destinations are introduced and then, conclusions about the development of smart destinations are presented.

2.3.1 Smart Destination characteristics

Smart destinations are special cases of smart cities that aim to enhance mobility (Gretzel, Sigala, et al., 2015), the overall tourism experience, improve the efficiency of resource management, maximize the destination's competitiveness and customers' satisfaction while also establishing sustainability (Buhalis & Amaranggana, 2013; Gretzel, Sigala, et al., 2015). Smart destination uses to its advantage the embedded technology, responsive processes at micro and macro levels, portable end-user devices and dynamically interconnected stakeholders that are engaged in using the platform. In smart destinations, ICT is used to coordinate all services and activities resulting in citizens and visitors that are well-informed, continuously connected and engaged. (Buhalis & Amaranggana, 2013.)

The key aspect of smart destinations is the integration of technology into the destination's infrastructure (Boes, Buhalis, & Inversini, 2015; Buhalis & Amaranggana, 2013; Gretzel, Sigala, et al., 2015). Since the technology is embedded on all organizations and entities, destinations exploit the synergies between the sensing technology and their social components to support the tourism experiences and to enrich them. The aim is to meet the tourists' needs before, during and after the visit with personalized and relevant services. (Buhalis & Amaranggana, 2013.) This is claimed to improve the destination's competitiveness (Boes et al., 2015; Buhalis & Amaranggana, 2013; Chiappa & Baggio, 2015; Wang, Li, & Li, 2013). The embedded technology and the following synergizing of different components of the destination also improves the quality of life of the citizens (Boes et al., 2015; Buhalis & Amaranggana, 2013; Gretzel, Sigala, et al., 2015), allows optimization of energy use and better traffic monitoring and control (Buhalis & Amaranggana, 2013). Smart destinations use a variety of technologies which are presented in more detail in chapter 2.2.

2.3.2 Examples of Smart Destinations

At the moment, there are countless smart destinations in the world as the smart tourism concept has spread globally. Some of these smart destinations and their smart tourism applications are presented here.

China has a smart tourism destination initiative by which they endeavor to transform their tourism destinations smart. They strive to integrate information on tourist activities, the state of tourism resources and the consumption of tourism products and then provide this information to companies, tourists and organizations. The information is shared by using different end-user devices to transform the tourism experience, change marketing strategies and to improve competitiveness. (Wang et al., 2013.) According to Wang et al. (2013) around 33 cities had participated in the initiative at the time their study was released. In the city of Sanya, IoT has been applied to tourism scenic spots. The entrance tickets contain RFID reader chips which enable tracking the tourists' location and their consumption habits. With this, location-based advertising is

possible. The system is also used for controlling the number of visitors on heritage sights to protect them from the negative impacts of overuse. The carrying capacity of the site is monitored by sensors that measure air quality, the amount of people and the consumption of energy. The system automatically also implements pricing strategies that affects the allowed visitor amount. (Wang et al., 2013.)

In the city of Nanjing, China, a mobile application provides information on attractions and services based on location tracking. These services recognize where the tourists are and offer them information about their surrounding attractions and other things such as coupon information from stores and restaurants. The application is connected to "Sina Weibo" which is a platform comparable to Twitter where tourist can share their experiences, stories and tips to other visitors in the same region. (Wang et al., 2013.)

The city of Natal, Brazil, hosted FIFA World Cup in 2014 which created a massive pressure on the city's infrastructure and services. The city prepared for this pressure by creating an initiative with a local university to transform the city into a smart tourism destination. They aimed to enhance the tourism experience through software programs that were designed to utilize the infrastructure mechanisms of the city. Their tourism application Find Natal "provides technologies to collect, process, share, store and analyze a vast amount of data coming from multipart sensing sources in order to turn data into powerful insights". (Cacho et al., 2015.) Find Natal has 3 components: a mobile tourist guide application, a Tourism Information System and a business intelligence infrastructure. The tourist guide application provides tourist information and collects data on tourists and their movements. The application sends the data to the Tourist Information System by using a cloud-based solution. The business intelligence infrastructure uses "spatiotemporal data mining methods to extract useful information out of the moving tourists' data". The information that this component offers helps to plan traffic and public mobility and to detect problems that come with the movement behavior. (Cacho et al., 2015.)

The European Union also pursues smart urban growth and ICT-driven development (Caragliu, del Bo, & Nijkamp, 2011). In Spain, Barcelona has interactive bus shelters that provide tourist information, buss timetables and ports for charging devices. Barcelona offers additionally environmentally friendly transportation: they have bicycles available around the city and visitors can locate them through a smartphone application. (Gretzel, Sigala, et al., 2015.) Stockholm, Sweden, uses sensors around the city to gather real-time data and uses it to offer accurate city information on different end-user devices (Buhalis & Amaranggana, 2013). In the Netherlands, Amsterdam Arena (a football stadium) is testing sensors for crowd management. There are also good examples outside of EU: Brisbane, Australia, uses beacons installed onto attractions and other points of interest that communicate information to visitors when they approach them and Seoul, Korea, aims to offer free wi-fi and smart phones to tourists. (Gretzel, Sigala, et al., 2015.)

Last but not least, Helsinki, Finland, won the EU's inaugural European Capital of Smart Tourism competition for 2019. Helsinki has ambitious goals: in 2013 they set out to be the "world's leading testbed for innovation". They have co-innovation platforms such as Maria 01 (the largest start-up community in the Nordic area) and Smart Mobility Lab which has the world's first trials of autonomous buses. Helsinki is also a good example of an open data city: the public information is made available for the private sector which has resulted in new digital practices, transparency in public administration and new tourism products. The open data offers hundreds of datasets, long-term statistics, real-time traffic information and location data. (Helsinki, 2018.) In addition to these smart destination characteristics, Helsinki concentrates considerably on sustainable development. The city of Helsinki plans to achieve carbon neutrality by the year 2035 by focusing on a carbon-neutral mobility system. (Helsinki, 2018b.)

2.3.3 The development of Smart Tourism Destinations

Tourism destination is an area selected by tourists that offers them all the necessary amenities such as restaurant services, accommodation and entertainment. Tourism destinations can be described as a mixture of tourist products and services that are offered to the tourists as an integrated experience. (Buhalis & Amaranggana, 2013.) According to Buhalis & Amaranggana (2013) a successful tourism destination consists of 6 things referred to as 6 A's, which are attractions, accessibility, amenities, available packages, activities and ancillary services. Attractions can be natural (mountains, lakes, rice fields), artificial (theme parks, theme villages) or cultural (music festivals, events). By accessibility, they mean all the transport systems, roads and routes, terminals, airports and public transportation. Amenities are all the services that help to facilitate a nice and a convenient stay, for example restaurant services, leisure activities such as spas and golf courts and accommodation. Available packages mean all the possible service bundles that are available for the tourist. Activities include every activity available in the tourist destination and ancillary services are daily services that are not primarily targeted for the visitors but exist in the destination such as bank services, postal services and hospital and health care. Creating and maintaining these 6 A's is very important in the tourism destination development since the tourism industry is highly competitive. Now that the technological development is pushing destinations towards interconnectivity, value co-creation and smartness, maintaining only these 6 A's is not sufficient anymore.

The foundations for smart cities and therefore for smart destinations are that they are instrumented, interconnected and intelligent (Harrison et al., 2010). The destinations must be instrumented so that they have the ability to collect and integrate real-world data by using many kinds of equipment such as sensors, meters, personal devices, security cameras, implanted devices, the web and other similar data-acquisition systems. These instruments can measure almost anything: pressure, flow, temperature, and also different IT systems and their diagnostics. The gathered data describes not only the measured aspects of

the physical systems, but also the virtual systems of the destination. The destinations are interconnected: the data gathered by instrumentation is "integrated throughout an end-to-end process, system, organization, industry or value chain" (Harrison et al., 2010). And lastly, the destination must be intelligent: the interconnected information is analyzed, and it brings forth new insights that guide decision making and actions that improve process outcomes. These outcomes must bring added value by changing the user's experience or the ecosystem. (Harrison et al., 2010.)

According to Boes et al. (2016) hard smartness and soft smartness are needed to create a smart destination. Hard smartness is ICT, or the presence of technology and soft smartness can be divided into 4 components: innovation, social capital, human capital and leadership. They state that the presence of soft smartness is essential since the mere integration of technology will not suffice in creating a smart destination. Their proposition is supported by earlier results of Ritchie & Crouch (2005), who suggest that human resources and innovation together with local and regional collaboration are important in the development of a tourism destination (Boes et al., 2015).

Boes et al. (2016) state that innovation drives smartness and smartness drives innovation. Innovation in a destination can be encouraged by creating "Living Labs" which are innovative and experimental user-centric ecosystems where the newest research and innovation processes are utilized collaboratively to develop new innovations, products, services and solutions. Current Living Labs tackle such issues as green energy, urban planning and sustainable practices. Public-private-people partnership is common in Living Labs and many researchers have stated that including local community, public sector and the private sector within the innovation process fosters efficiency, supports creativity and improves the quality of life for residents and tourists. (Boes et al., 2015, 2016, Buhalis & Amaranggana, 2013, 2015.)

Social capital includes the different networks between people, organizations and communities and the shared values, norms and cooperation between them. Smart cities should encourage the collaboration between the 5P's: "public-private-professor-people partnerships". Collaboration, co-creation and co-development are fundamental for the success of a smart destination since individual competition has negative effects on the long-term development of the destination. (Boes et al., 2016.)

Human capital consists of knowledge, skills and competencies that aid the creation of innovative developments and well-being. Human capital is essential in smart places and is the core of value creation, competitiveness and innovation. The places with high human capital have a common factor: an effective educational system. Well-educated, creative and knowledgeable people facilitate the success of smartness. (Boes et al., 2016.)

According to Boes et al. (2016), the chosen leadership approach has an influence on whether or not the adoption of technology induces smartness. Alternative and supporting leadership style choices are needed to take full advantage of smartness. The administration and leaders should have a supporting

role that encourages companies and the public to open data use and collaboration in the destination (Boes et al., 2015; Buhalis & Amaranggana, 2013, 2015). Strong determination to deliver smartness is needed. This alternative and dynamic leadership covers governance, policies, regulations and laws.

Building a smart tourism destination is a complex endeavor: in addition to attending to the before mentioned 6 A's, one must focus on creating a prolific environment applying dynamic leadership, where human capital, social capital and innovation are encouraged to grow. This will improve not only the tourism experiences and the tourism environment, but also the quality of life for the residents. Creating a smart tourism destination requires inclusive ecosystem design that takes all the actors in the region into consideration and includes them in the destination development.

2.4 The impacts of tourism

Tourism is one of the largest industries in the world and the business volume of tourism has surpassed even oil exports, food products and automobiles (UNWTO, 2019b). Tourism is a viable economic strategy (Harrill, 2004) and is the main source of income for many countries (Casagrandi & Rinaldi, 2002), especially for developing countries (UNWTO, 2019b). The spread of tourism, be it smart or traditional, has generated economic and employment benefits in many sectors but it has also brought on many negative impacts and phenomena. Tourism generates employment, income and tax revenues and brings forth regional development (Mckercher, 1993). But on the other hand, tourism uses extensive water resources, shapes large pieces of land and produces a great amount of waste, litter and sewage (May, 1991) which have a substantial influence on the nature of the tourism destination and the overall environment. In this chapter, the focus is mainly on the negative impacts of tourism. The impacts of tourism are divided into environmental impacts and sociocultural impacts.

2.4.1 Environmental impacts

Tourism is a considerable contributor to the global greenhouse gas emissions. It has been estimated that the tourism sector and its activities account for 5.2-12.5% of global warming potential. The amount of emissions is caused by travel, accommodation and related activities. Aviation is the largest travel-based polluter contributing as much as 40%to CO_2 emissions of all tourist transport. In addition to generating greenhouse gas emissions, the tourism sector uses a large amount of energy. Most energy is used in space heating or air conditioning and warming up water. (Pan et al., 2018). In Torremolinos, Spain, tourism accounts for about 40% of the total electricity consumption (European Environment Agency, 2015).

If compared globally, the amount of water used by tourism industry is small compared to agriculture, industry or domestic use. Nevertheless, in certain areas, the water used by the tourism industry can be a large part of the total water use of the area. (Pan et al., 2018.) This extensive water usage can be a hindrance to the local population: the water needed by the local farmers and villages are often redirected for the use of the tourism sector (Archer, Cooper, & Ruhanen, 2005). The water is used in golf courses, hotel gardens, swimming pools, spas and showers (Pan et al., 2018). Research also shows that a tourist consumes 3 or 4 times more water per day than a local resident (European Environment Agency, 2015).

The tourism sector and its activities generate a large amount of waste. Several studies report increases in municipal solid waste during the tourist seasons (European Environment Agency, 2015). Archer et al. (2005) aptly describe the waste accumulation of tourism:

> From one mountain alone in Great Britain during the summer months, almost a ton of litter a day (mainly discarded lunch wrappings) is brought down from the summit, whereas from the New Forest in Southern England approximately 25,000 empty bottles are retrieved each year. (Archer et al., 2005, p. 92)

Even though waste management and waste utilization have been recognized as industry challenges a long time ago, they are still topical and important issues. Inappropriate waste management and treatment is a particular problem on small islands, where all negative effects accumulate more quickly (European Environment Agency, 2015). Tourism also effects the quality of water through discharge of sewage and abstraction of freshwater. Poor wastewater management can cause eutrophication of lakes and water pollution when, for example, organic particles, chlorine loads and chemicals are discharged with sewage into the rivers and seas. (Archer et al., 2005; Pan et al., 2018.)

Large scale tourism brings about loss of biodiversity and habitat and landscape destruction (Pan et al., 2018). The building of beach resorts damages coastal wetlands, large forest areas are cleared for tourist resort areas and marshlands and mangrove swamps have been drained to create tourist docks. In the mountain areas, forests have been cut down to clear way for ski slopes which has resulted in soil erosion, mud slips and flooding. (Archer et al., 2005.) The list of the possible damages to the biodiversity is long: damage to coral, clouded water, reduced populations or even extinctions of species, noise pollution (May, 1991), disruption of natural currents (Pan et al., 2018), destruction of original ecosystems (Mckercher, 1993), disturbed wildlife and “alien forms of plant life” introduced to ecosystems by visitors (Archer et al., 2005).

Given all the negative effects that tourism has on the environment, it is clear that the tourism sector still has a large amount of crucial issues to resolve in terms of sustainable development. Much progress has been made in recent decades, such as the development of efficient water purification and green electricity, but the journey towards environmental sustainability is still underway.

2.4.2 Sociocultural impacts

Sociocultural impacts of tourism mean the impacts that tourism has on the local population's culture, heritage and society (Archer et al., 2005). The travel destinations are inhabited by people and this local population (hosts) might have different values in their style of work, dressing, architecture and religion. The hosts' values and culture can be affected and modified by intensive tourist behavior when the guests' values and culture clash with the ones of the hosts. (May, 1991.) Some studied negative sociocultural impacts are alcoholism, drug addiction, crimes (individual and organized), openness to sex and congested traffic conditions (King, Pizam, & Milman, 1993).

Since tourism activity is mainly motivated by the cultural heritage of a specific area (Pan et al., 2018), cultural vulnerability is a major concern. Unique heritages and cultural attributes are at risk when encountering tourism. In fact, tourism has been called "the pariah that destroys host societies and cultures" (Mckercher, 1993). Tourism usually increases the local traffic and causes traffic congestion, increases prices on land, real-estate and products in the area and might restrict access of some areas where the local people used to live (Mckercher, 1993). Thus, in addition to the negative environmental impacts, tourism entails a large number of possible impacts that threaten the destination's culture, religions, attitudes and lifestyle.

3 GREEN INFORMATION TECHNOLOGY

The global business environment is dynamic and changes rapidly which is why firms must adapt, transform and respond at the same pace. Despite the economic growth of last two decades there are still major concerns - natural resources and the state of the environment. Corporate responsibility and sustainability are important forces that evoke change in the modern business environment. (Dao et al., 2011.) The modern agenda is to overcome environmental issues and to adopt environmentally sound approaches, models and practices (Murugesan, 2008).

This chapter focuses on explaining the field of green Information Technology, later referred to as green IT. First, the concept of green IT, its dimensions and directions are explained. Then, the impacts of IT on the environment are described. Common green IT practices and approaches and the benefits of green IT on both the environment and to the organization are presented. Lastly, the most recognized and used green IT frameworks are introduced.

3.1 Green IT

Green IT means information technology that is sustainable and environmentally sound (Jenkin, Webster, & McShane, 2011; Mingay, 2007; Molla et al., 2008; Murugesan, 2008). Its leading goal is to decrease the harmful effects on the environment (Jenkin et al., 2011) with environmentally sustainable IT, IT applications and practices (Murugesan & Gangadharan, 2012. p. 5). Molla et al. (2008) offer an inclusive definition of green IT with specific examples:

> a holistic and systematic approach to address the challenges surrounding the IT infrastructure such as data center space and energy efficiency; IT's contribution to reducing the environmental impacts of business IT activities (such as through adopting green technologies), IT's support for environmentally sustainable business practices (such as in enabling green supply chain management through carbon foot print monitoring through building tools for energy management options) and IT's role (such as

> supplanting high CO2 emitting business practices) in the low-carbon economy (Molla et al., 2008, p. 671).

As suggested by Molla et al. (2008), green IT is a holistic approach that addresses the negative environmental impacts caused by the existence and use of IT and also strives towards a more sustainable world by developing sustainable business practices and tools that can be used in decreasing processes' negative impacts.

According to Murugesan & Gangadharan (2012) green IT can be divided into three complementary dimensions which are IT enabled approaches that improve sustainability. These dimensions are:

1. Greening IT systems and usage (direct): designing, manufacturing, using and disposing technology, systems and software efficiently with minimal impact on the environment.
2. Using IT to support environmental sustainability (indirect): supporting and assisting enterprise-wide initiatives and processes with the use of IT.
3. Using IT to create green awareness: using IT in creating green awareness, endorsing green agenda and promoting green initiatives among stakeholders.

These three dimensions complement each other, and they are all needed to achieve a sustainable economy. (Murugesan & Gangadharan, 2012, p. 5.) Green IT can affect the environment directly by decreasing the negative impacts of IT or indirectly when technologies or information systems are used to support business processes and initiatives to decrease negative environmental effects (Jenkin et al., 2011). The indirect effects appear trough green IT's effect on different practices such as supply chain management, product and service design, enterprise operations and resource management (Jenkin et al., 2011; Mingay, 2007; Molla et al., 2008; Murugesan, 2008). IT can be used, for example, in creating energy efficient buildings, helping decision making and analyzing and making business operations more energy efficient (Murugesan & Gangadharan, 2012. p. 7).

The indirect effect of green IT is remarkable: in the enterprise context, green IT can be defined as the optimal use of ICT to ensure the enterprise's environmental sustainability within its operations, supply chains, products, services and resources (Mingay, 2007). Since the majority of the world's emissions come from non-technological sources, the use of IT in supporting business processes can create significant energy savings and notably improve the overall environmental sustainability. In addition to the direct and indirect approaches, the spread of green awareness can generate behavior change in stakeholders and consumers. Favoring green vendors and green suppliers, disposing of products in the right manner and decreasing consumption all have a positive effect on the environment.

Along with the three dimensions presented above, Murugesan & Gangadharan (2012) have composed a holistic approach to greening IT. If we want to decrease the negative impacts of IT effectively and thoroughly, a holistic approach is needed. They have gathered six complimentary directions for achieving total environmental sustainability for IT, which are:

1. Green design
2. Green manufacturing
3. Green use
4. Green disposal
5. Green standards and metrics
6. Green IT strategies and policies

Green design contains designing energy efficient and environmentally sound equipment and components. Green manufacturing strives to manufacture different electronic components and devices with minimal effect on the environment. Green use includes the reduction of energy consumption and training users to use technology in an environmentally sustainable manner. Green disposal involves recycling, reusing and remodeling IT equipment to extend their life span. Green standards and metrics are needed for measuring, comparing and benchmarking different sustainability related initiatives, products and services. And finally, green IT strategies and policies add focus on benefits when they are aligned with business strategies and practices. Green IT strategies and policies are key components in greening IT. (Murugesan & Gangadharan, 2012. p. 7.)

Green IT tackles many concerns, such as economic, social and environmental concerns and functions as a strategic differentiator among firms (Molla et al., 2008). Green IT also enables other green initiatives (Molla et al., 2008), strives towards economic viability, offers improved system performance and encourages total cost ownership (Murugesan, 2008) and resource efficiency (Mingay, 2007; Murugesan, 2008) while respecting ethical and social responsibilities (Murugesan, 2008). Green IT is therefore an immense opportunity for organizations to reduce their environmental impact and carbon footprint (Mingay, 2007; Molla et al., 2008). Since IT has a role in every industry, the impact of green IT is presumably grand.

3.1.1 IT and the environment

Most people might not realize that the creation and use of information technology causes environmental problems. According to Molla et al. (2008) ICT accounts for 2% of global CO_2 emissions, which is equal to the amount caused by the aviation industry. Mishra, Akman, & Mishra (2014) state that the IT sector produced 1.3% of global greenhouse gas emissions and used 3.9% of all electricity in 2007. The use of Internet accounts for 10% of all energy consumption in the US (Mishra et al., 2014). The use of IT and information systems has in-

creased exponentially and the amount of energy they require is a large portion of firms' and businesses' total energy costs (Jenkin et al., 2011). According to Jenkin et al. (2011) more than 50% of this energy use is going to waste because of "inefficient technologies, poorly designed systems, or uninformed behaviors" (Jenkin et al., 2011). Information technology's lifecycle, meaning every stage of the equipment's life from design, production and use to its disposal, produce environmental issues (Mishra et al., 2014; Murugesan, 2008). The manufacturing of IT consumes a massive amount of energy, raw materials, chemicals and water and produces hazardous or toxic waste. All of these increase carbon dioxide emissions and impact heavily on the environment. (Murugesan, 2008.)

Electricity consumption is an important cause of climate change. If the electricity used is created from coal or oil, not only natural resources are reduced, but also carbon dioxide, sulfur and other pollutants are released into the air. These emissions have many negative outputs such as respiratory disease, smog, acid rains and climate change. The total energy consumption increases steadily: the different IT equipment (servers, monitors, computers, data communication equipment, cooling systems etc.) need electricity and energy to function. The increasing amount of energy consumption means also increasing amounts of greenhouse gasses. (Murugesan, 2008.) According to Murugesan (2008) "each PC in use generates about a ton of carbon dioxide every year".

The IT equipment, such as mobile phones and computers, batteries and monitors, are built from electronic components which contain toxic materials. The average product lifecycle is not long: people dispose their computers and other electronics 2-3 years from purchase and upgrade them for newer models. Most of these abandoned devices end up in landfills which causes pollution of earth and contamination of water. (Murugesan, 2008.) In Australia, over "1.6 million computers are dumped in landfills each year and e-waste is growing faster than general municipal waste" (Mishra et al., 2014).

The number of computers and other electronic devices is bigger than ever and is still increasing, and the devices are replaced frequently (Murugesan, 2008). This causes the environmental impact of IT to be a major concern. IT artifacts have relatively short lifespans: laptops endure 3-4 years and networks 5-7 years. Electronic waste is one of the fastest growing waste and simultaneously companies and people are replacing their still working devices for newer ones. One can say that the development of IT entails overuse of scarce resources and increased power consumption. (Mishra et al., 2014.)

IT has significant negative effects on the environment. This is why the IT industry, its organizations and individuals should strive to create IT that is environmentally friendly through its lifecycle, from creation to disposal or reuse. Green IT offers solutions on how to decrease or to eliminate these negative environmental effects of IT. Some of these green IT practices and approaches are presented in the following chapter.

3.1.2 Green IT practices and approaches

The negative environmental impacts of information technology presented in chapter 3.1.1 can be reduced in many ways. This chapter introduces some of these green practices and approaches that are used in reducing IT's environmental impact. This chapter also includes some examples of how IT can be used to decrease the negative environmental impacts of organizational activities.

Minimizing energy consumption is a key objective for green IT, since reducing energy consumption reduces greenhouse gas emissions. The equipment that consume the most energy for no reason are personal computers – PCs. Most PCs are left running even when not in use which is a clear waste of electricity. Computers and other devices generate heat when their power is on and the devices require cooling systems to prevent overheating. Cooling systems need electricity which increases the device's power consumption. The more electricity is used, the more costs accumulate for the firm. (Murugesan, 2008.) Although the energy savings from a computer might seem unimportant and small, the combined savings from all the computers used are plentiful.

To decrease the energy consumption of PCs, firms must make small organizational changes on how they use computers (Molla et al., 2008; Murugesan, 2008). These energy efficient computer habits include enabling the power management features of devices, turning the system off when not in use, using screensavers and using thin client computers (Murugesan, 2008). PCs can be programmed to switch to energy saving mode automatically when not in use which has a surprisingly large effect: the sleep mode reduces the total energy usage of PCs by 60-70% (Murugesan, 2008). Turning off the system seems to be the easiest way to save energy but regardless, many people do not do this because they want to save time. Thin-client computers are lightweight computers that are optimized establishing a remote connection with a server-based computing environment. They consume about a fifth of the power of a PC (Murugesan, 2008). These computer habits can be easily adopted but they will not become a reality if the people using PCs are not willingly involved in the energy saving agenda. For the adoption to be successful, the firms must educate their employees on sustainability and computer use.

The fast spreading of the Internet has caused rapid growth of data centers. Data centers are spaces that are dedicated to housing computer systems, servers and associated components. Firms are continuously expanding their capacity and installing more servers. The server models used nowadays consume more energy than older models and the aggregate amount of electricity used by servers "doubled between 2000 and 2005, most of which came from businesses installing large numbers of new servers" (Murugesan, 2008). The price of energy has inflated globally which increases the costs of data centers. Murugesan (2008) states that the availability of electrical power is a critical issue for data center development. Data centers' efficiency can be improved by energy efficient equipment, improved airflow management for cooling, energy management software and eco-friendly data center design. A very efficient mean to improve

a data center's efficiency is to switch to liquid cooling, since it is remarkably more efficient than air cooling. In spite of this fact, professionals are still reluctant to use liquid cooling which might be because of its complexity. (Murugesan, 2008.)

Energy costs are about 30% of a data center's total operating expenses and a large amount of it is used for cooling. To reduce the energy usage (and total expenses) data centers should have cooling technologies that are more efficient, for example liquid. In addition, they should have high-density servers that use hydrogen fuel cells for power and apply virtualization technologies. This reduces the total power consumption of servers and the heat produced. (Murugesan, 2008.) Virtualization of servers means that there is one physical server that hosts many virtual servers. Hosting multiple virtual servers on fewer but more powerful servers saves a large amount of energy and simplifies the data center. It also "reduces data center floor space, makes better use of computing power and reduces the data center's energy demands" (Murugesan, 2008).

Designing of a data center has a large impact on the energy usage. According to Murugesan (2008) "eco-friendly data center designs use synthetic white rubber roof, paint, and carpet that contain a low volatile organic compound (VOC), counters made from recycled material, energy efficient mechanical and electrical systems" (Murugesan, 2008). Natural sources such as light and wind can be used for energy – a data center might have its own solar panels. Many firms have adopted LEED standards (Leadership in Energy and Environmental Design) that concentrate on five key areas: sustainable site development, water saving, energy efficiency, materials selection and indoor environmental quality. Green design also encourages using non-toxic materials that consume less energy. (Murugesan, 2008.)

IT can be used to support and assist other initiatives to achieve environmental sustainability. IT can offer "innovative modeling, simulation and decision support tools" (Murugesan, 2008). Different software tools can be used for analyzing and modeling different environmental impacts and effects. Simulating effects is also possible with IT, which is why these tools are great for environmental risk management. IT is used for auditing energy consumption and observing the amount of greenhouse gas emissions. Different environmental knowledge management systems such as geographic information systems allow enterprises to capture, store, manipulate and present environmental data. (Murugesan, 2008) These systems are used for engineering, planning, logistics and business (Maliene, Grigonis, Palevičius, & Griffiths, 2011). The analyzed data offer firms environmental knowledge in decision making and supports sustainable decisions.

Many technology companies have environmental strategies. For example, Dell has a "Zero Carbon Initiative" that strives to maximize Dell's products' energy efficiency and plans to compensate their carbon impact. They require their suppliers to report their greenhouse gas emissions publicly. (Mingay, 2007; Murugesan, 2008.) In addition to the practices mentioned before, the literature mentions reusing, refurbishing and recycling old devices (Murugesan, 2008),

sourcing from green vendors (Molla et al., 2008) and substituting work related traveling with videoconferencing or using other communication and collaboration tools to build an infrastructure and culture that supports remote collaboration (Mingay, 2007).

Designing, manufacturing, using and disposing information technology cause negative impacts on the environment. Green IT approaches and practices present multiple means to tackle these impacts. Minimization of energy consumption can be achieved by PC power management, energy efficient cooling systems, green data center design and server virtualization. In addition to these methods, the energy used can be derived from natural sources and IT systems can be used to audit and keep track of energy use. The approaches presented in this chapter are the most common examples from green IT literature but there are many more possible approaches and solutions to use in "greening" enterprise's operations.

3.2 The benefits of green IT

Harnessing green IT principles, practices and approaches in the organization's processes delivers many benefits that affect not only the environment, but also the organization itself. The positive impacts and benefits of green IT are presented in this chapter. First, the focus is on the benefits on the environment and then on the benefits that are associated with the organization itself.

3.2.1 Benefits of green IT on the environment

Chapter 3.1.1 presented the negative effects of IT on the environment. The development of IT and IT devices consumes raw materials, chemicals and water and creates hazardous and toxic waste. Electronic devices consume a massive amount of energy, which increases the amount of greenhouse gas emissions and depletes natural resources, if the energy is produced from coal or oil. In addition, carbon dioxide, sulfur and other pollutants are released into the atmosphere. Since green IT's goal is to produce technology sustainably, these before mentioned negative impacts should decrease or their impact should be smaller when green IT principles are implemented.

Green IT (and green IS) has the potential to reduce greenhouse gas emissions by 15% (Jenkin et al., 2011; Murugesan, 2008). Green IT's benefits on the environment come from the improvements on energy efficiency, lowered greenhouse gas emissions, the usage of less harmful materials and the encouragement to reuse and recycle electronic devices and their components (Murugesan, 2008). Reusing, refurbishing and recycling decreases the amount of toxic electronic waste. Green IT helps to lower organizations' carbon footprint and the overall level of waste and pollution (Molla et al., 2008). Green IT has a notable effect on the total energy consumption. The gained energy effi-

ciency and the decreased amount of electricity needed lowers emissions. IT and IS can be used to "monitor and optimize the energy efficiency of any process" (Mishra et al., 2014) which is why green IT can bring forth a change in any industry.

One good example, of how green IT can indirectly affect the environment positively, is the usage of collaborative communication software and telepresence systems instead of traveling to another location for work related meetings (Jenkin et al., 2011). This allows firms to reduce their negative impact on the environment that is associated with traveling. In addition to all these benefits mentioned above, one might conclude that these benefits have a positive influence also on the health of people and animals.

3.2.2 Benefits of green IT on organizations

The two main benefits of green IT on organizations mentioned in the Green IT literature are competitive advantage and financial/economic benefits. Companies that can offer solutions, products and services that address environmental issues can be more attractive for customers, since customers are increasingly taking the company's environmental records and initiatives into consideration when making purchasing decisions. Investors and consumers are demanding more from companies in the environmental sense: they want the company's carbon footprint, environmental initiatives and achievements to be disclosed publicly. (Murugesan, 2008.) This has resulted in companies showing their environmental credentials because they want to build a more positive brand image and influence the mindset of the customers (Molla et al., 2008). Customers seem to prefer working with eco-friendly companies (Murugesan, 2008) which have a higher CSR (Company Social Responsibility) awareness (Molla et al., 2008). According to Molla et al. (2008) a higher CSR awareness has a positive effect on consumption, investments and employment. Since ethical concerns are increasingly influencing the purchasing decisions, green IT solutions offer companies indisputable competitive advantage. Competitive advantage is discussed in the green IT literature also by Dao et al. (2011), Gholami, Shirazi, Ravishankar & Machet (2017) and Mingay (2007).

Adopting green IT practices, approaches and initiatives in the firm's strategy, design and practice helps firms to achieve energy efficiency which results in energy savings and lower total costs (Murugesan, 2008). Green IT seems to be a distinct opportunity for firms to lower their expenses and avoid unnecessary costs (Mingay, 2007). According to a survey by Sun Microsystems Australia, it was studied that the main reasons for eco-responsible practices were reducing power consumption and lowering costs. The survey gathered 1500 responses from 758 large and small organizations in Australia and New Zealand. (Murugesan, 2008.) In the US, the companies tend to worry first about cost savings and in Europe, the environmental issues come first (Mingay, 2007). In addition to cost savings, companies that concentrate on solving their operations' environmental issues seem to achieve better and have a healthier financial per-

formance (Molla et al., 2008). Dao et al. (2011) suggest that addressing environmental issues and sustainability is critical for a firm's success and long-term existence. Environmentally conscious firms have increased their market value.

Environmental performance and economic performance are clearly positively linked. Companies that include green IT practices and approaches into their processes enjoy competitive advantage and better economic viability. "Going green" is also supported by governments: firms that adopt eco-friendliness into their design are offered tax incentives in many countries (Dao et al., 2011).

3.3 Green ICT-frameworks

Successful ICT sustainability strategies usually involve adopting an integrated framework along all the organization's processes. These frameworks usually cover three main areas: preparation and planning for sustainability, implementing sustainability initiatives and communicating and promoting sustainability initiatives. (Gholami et al., 2017.) Sustainability strategies involve some challenges, which is why these frameworks are useful tools for firms aiming towards sustainability. The subject of sustainability is complex, and it has emerged and spread very fast in the business field. Therefore, there are no fixed and complete standards that all could comply with. Moving towards sustainability goals within the business requires the stakeholder expectations to be reformed and new metrics and measures to be deployed. (Donnellan, Sheridan, & Curry, 2011.) These are some of the challenges that firms face in the business world that is "going green". Sustainability frameworks can be used as a means to resolve these challenges.

Resent research offers many models that asses the maturity levels of sustainable ICT strategies. The most recognized and used frameworks for analyzing sustainability capabilities of organizations are presented in this chapter. The frameworks presented here are The OECD Green IT Framework (OECD, 2010), the G-Readiness framework by Molla et al. (2008) and The Sustainable ICT-capability maturity framework (SICT-CMF) by Donnellan et al. (2011). The first model is a fairly simple categorization of IT's environmental impacts and the other two are frameworks that measure readiness and maturity of green IT sustainability.

3.3.1 OECD Green IT Framework

The Organization for Economic Co-operation and Development (OECD) Green IT Framework is composed of three levels: direct impacts of IT, enabling impacts of IT and systemic impacts of IT (Murugesan & Gangadharan, 2012, p. 6). These levels are very similar to the "Green IT Dimensions" by Murugesan & Gangadharan presented in chapter 3.1.

The direct impacts of IT include the positive and negative impacts that result from the existence of different IT artifacts and goods, IT services and related processes. These impacts are generated by IT manufacturers, suppliers, intermediaries, goods producers and consumer users of ICT. The direct negative impacts of IT can be reduced by green design, green manufacturing, green use and green disposal. (Murugesan & Gangadharan, 2012, p. 6.)

The enabling impacts of IT include the effects that result from the use of IT applications that help to reduce negative environmental impacts of business and social processes. IT can be used for resource optimization, integration or substitution and dematerialization. IT can be employed for designing, manufacturing, using and disposing of products more resource efficiently and with lesser negative environmental impacts. These enabling impacts are indirect effects of how IT can be used as an instrument to decrease negative environmental impacts. (Murugesan & Gangadharan, 2012, p. 6.)

The systemic impacts of IT include more wide-spread and pervasive phenomena such as behavioral change, process change, promoting green agenda and creating green awareness. These are non-technological factors that are related to culture, behavior and attitude that can be generated by IT applications, firms, people and processes. (Murugesan & Gangadharan, 2012, p. 6.)

The OECD Green IT framework is a simple categorization of IT's environmental impacts by OECD in 2010. The levels of impacts are compatible with the "Green IT Dimensions" by Murugesan & Gangadharan (2012) which are greening IT systems and usage, using IT to support environmental sustainability and using IT to create green awareness.

3.3.2 The G-Readiness framework

The G-Readiness framework was formed to help organizations to understand their readiness to adopt green IT principles. Current green regulations might be voluntary, but in the future, they might become mandatory by law and environment-based taxes will probably become more common. In addition, consumer and investor interest in environmentally conscious choices is expected to grow. All in all, green choices are predicted to become more mainstream and frameworks such as this are needed. (Molla et al., 2008.)

The concept of G-Readiness is a combination formed by adopting e-readiness frameworks, green IT literature and sustainable business practice and CSR (Corporate Social Responsibility) literature. The framework presents factors that enable "the spread and usage" of green IT and takes into account the roles that different key stakeholders might have (Molla et al., 2008). It is a holistic view on how to implement green IT in the business and into its business processes. There are 5 factors that together form the G-readiness: attitude, policy, practice, technology and governance. The combination of these five critical factors enables the organization to implement sustainable IT and processes. The G-readiness is a measure on how prepared the organization is to support its

green IT initiatives. The factors of the G-Readiness framework are visualized in Figure 2. (Molla et al., 2008.)

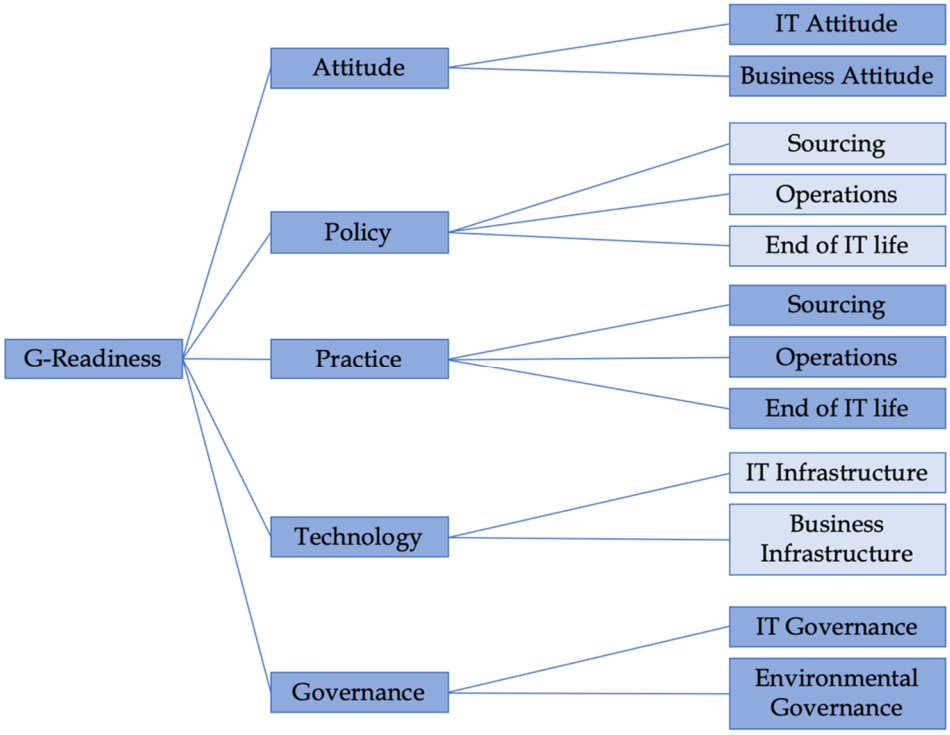

Figure 2. The G-Readiness Framework (Molla et al., 2008)

The attitude factor measures the IT and business leaders' emotional characteristics. It is a measure of how interested and invested the leaders are in concerns related to the use of IT. The concerns can be not only environmental and social, but also economical, strategic and regulatory. Since emotional appeal is a stronger factor in influencing and encouraging people to act than logical reasoning or facts, the extent of actions taken by the organization to tackle green IT issues depends mostly on the leaders' personal attitudes on environmental concerns. Molla et al. (2008) suggest that green attitude is dependent on subjective motivation and subjective capabilities. Subjective motivation stands for the personal reasons for supporting the green agenda. Subjective capabilities denote the person's own perception of whether or not his/her actions have an effect in the environmental sense. It is a question whether the person feels that she/he has capabilities to influence the matter personally. The attitude factor is divided into IT attitude and business attitude, since they both are needed. (Molla et al., 2008.)

Policy readiness measures how broadly green and sustainable policies are developed throughout the organization and its value chain. Policy readiness can be divided into three value chain areas which are IT sourcing policy, IT operations and services policy and IT end-of-life policy. IT sourcing policy concerns green and environmentally friendly purchasing policy. It encourages organizations to purchase from suppliers that follow green guidelines and buying products that have a minimal negative impact on the environment. This means

avoiding energy-intensive production methods, wasteful packaging, poor recycling practices and hazardous materials. IT operations and services policy concerns the services provided by the IT infrastructure and how do they comply with business sustainability. These policies can be for example PC power management and staff computer usage policy. IT end-of-life policy means the policies that concern the disposal of IT equipment. In some countries recycling of IT equipment is mandatory by law, as in Japan. When assessing the G-Readiness of organization's policies, one must measure it by all of these three categories. (Molla et al., 2008.)

Since organizations might not always apply their policies in practice, **practice** readiness is used to measure how organizations have turned their policies into actions. These practices are divided into three categories: green IT sourcing practice, green IT operations and services practices and green IT end of life management practices. Green IT sourcing practice measures how environmental issues are taken into consideration with purchasing decisions. Green sourcing means valuating suppliers' environmental behavior and choosing to purchase from green suppliers. Green IT operations and services practices "can range from clients through servers and people to network critical physical infrastructure (NCPI)" (Molla et al., 2008). The operational actions aim to reduce power consumption in different ways: retiring old systems, using current system in a more efficient manner and using energy efficient equipment. The practices also include how employees use the technology. Green IT end of life management practices measure how IT's end-of-life policies are implemented. This means reusing, recycling and refurbishing IT equipment, packaging and materials not only from the organizations point of view, but it also takes suppliers, resellers and users into consideration. (Molla et al., 2008.)

The technology aspect of G-Readiness measures technological indicators, such as green business infrastructure, green power sources, development of green standards, server virtualization, IT recycling and development of solutions to support the organization's green initiatives. (Molla et al., 2008.)

Governance means the management of implementing green IT. This means defining roles, accountability, control and responsibilities for IT initiatives. Green IT requires a well-established management infrastructure to be implemented efficiently. The indicators of G-Readiness of governance include for example definitions of roles, existence of standards administrative processes, and budget for green IT. (Molla et al., 2008.)

The G-Readiness framework measures the preparedness and readiness of the organization to adopt green IT. It has 5 key factors, which are attitude, policy, practice, technology and governance. These factors are divided into 2 or 3 sub-categories, that can be assessed and measured. The framework is a holistic approach to understanding organization's green IT and takes into consideration the economic, environmental, strategic, technological and social concerns. The different factors can be considered also as barriers, if they are nor developed well in the organization. (Molla et al., 2008.) Therefore, the framework can be used not only as a tool to measure G-Readiness, but also as a guideline on

which steps to take towards environmentally responsible and competitive business.

3.3.3 The Sustainable ICT-capability maturity framework (SICT-CMF)

The Sustainable ICT-Capability Maturity Framework (SICT-CMF) is a framework for methodical assessment of the organization's sustainable ICT capabilities (Donnellan et al., 2011; Gholami et al., 2017). SICT-CMF's valuation methodology indicates how the organization's sustainable ICT capabilities are promoting the sustainability goals and objectives of the organization. (Donnellan et al., 2011.) The framework offers an all-inclusive model which aids the organization to organize, appraise, plan and govern their sustainable ICT capabilities. The framework is based on other approaches that measure SICT-maturity, such as the G-Readiness Framework presented in 3.3.2. Therefore, they have several similarities.

The framework allows organizations to measure their own maturity level of sustainability (Gholami et al., 2017). It assists firms in identifying capability gaps and provides direction in the improvement of sustainable ICT performance. The differences in what the company aims to achieve and how their ICT achieves it in their current state can be used as a management tool. (Donnellan et al., 2011.)

The SICT-CMF by Donnellan et al. (2011) has four key actions:

1) defining the scope and goal of sustainable ICT in the organization,
2) understanding the current maturity level of SICT capabilities,
3) analytically developing and managing SICT "building blocks"
4) evaluating and managing SICT progress over time.

These four key actions are outlined and explained in more detail in this chapter.

Defining the scope and goal of SICT

First, it is essential that the organization defines the scope of their SICT effort. They should identify their attitude towards sustainability and the organization's prevailing views concerning sustainability and their own SICT objectives. Settling upon common sustainable business posture is important because it has a significant impact on SICT goals and objectives and how they are met. When the scope is clear, aiming toward consistent development is less complicated. (Donnellan et al., 2011.)

Second, the specific goals and objectives of the SICT effort must be determined. Since ICT is used as a tool to meet the organization's business objectives, it is imperative that the business objectives are clear and SICT's role in enabling these objectives is determined. These goals are best achieved if the IT and business stakeholders have a transparent agreement and shared understanding on business and sustainability goals. (Donnellan et al., 2011.)

Understanding the maturity level of SICT capabilities

When the organization has set the scope and the objectives for their SICT effort, they need to understand their current state of sustainability. This is done by assessing their capability maturity level. The organization's attitude towards SICT and its interpretation on SICT's impact on sustainability are assessed and examined through different business functions. (Donnellan et al., 2011.)

The SICT-CMF has "a five-level maturity curve". In addition to defining the current status, the curve provides a clear growth path and presents the next capabilities the organization should develop. The five levels are initial, basic, intermediate, advanced and optimizing. (Donnellan et al., 2011.) The five levels and their main characteristics are presented in Table 1.

Table 1. Maturity Levels of Sustainable ICT (Donnellan et al., 2011)

Level of maturity	**Characteristics of the organization in relation to SICT**
Initial	• Little understanding on the topic and few or no policies related to SICT. • Accountabilities are not defined. • Sustainability is not considered in the systems' lifecycle.
Basic	• A limited SICT strategy that lacks consistency. • Increased awareness on the subject has been reached but there are no established accountabilities. • Some policies might exist, but they are not adopted consistently.
Intermediate	• A SICT strategy with related plans and priorities. • Capabilities and skills have been developed. • The organization encourages people to contribute to sustainability programs. • SICT is embedded across systems' life cycle. • Targets are tracked on individual project basis.
Advanced	• Sustainability is a core component of IT and business planning. • IT and business drive programs and progress in tandem. • SICT is recognized as a significant contributor in the sustainability strategy. • Business and IT metrics are aligned to achieve success across the organization. • The organization designs policies to enable best practices.
Optimizing	• SICT is employed across the extended enterprise to include customers, suppliers etc. • The organization is recognized as a sustainability leader and the SICT practices are used to improve industry standards. • SICT is recognized as a key factor in driving sustainability and as a competitive differentiator.

Identifying the maturity level assists the organization to realize gaps and capabilities they need to develop to achieve their sustainability goals through ICT. The assessment of the maturity level is usually conducted by interviewing IT and business personnel who are somehow responsible for SICT.

Developing and managing SICT "building blocks"

Organizations have specific capabilities that are related to SICT which are called "SICT capability building blocks". In addition to understanding the more broadly defined maturity level, it is important to focus on specific capabilities that are related to SICT. The SICT-CMF is comprised of nine capability building blocks that are divided to four categories. (Donnellan et al., 2011.) The categories, building blocks and their descriptions are presented in Table 2.

Table 2. Capability building blocks of SICT (Donnellan et al., 2011)

Category	Block	Description
Strategy & Planning	Alignment	Align SICT strategy with the business sustainability objectives.
	Objectives	Objectives of sustainable ICT.
Process Management	Operations and life cycle	Source, operate, dispose ICT according to sustainability objectives.
	ICT-enabled business processes	Provisions for ICT systems that enable improved sustainability outcomes across the extended organization.
	Performance and reporting	Report and demonstrate progress against objectives.
People and Culture	Adoption	Assimilate sustainability principles across ICT and the organization.
	Language	Define, communicate and use common sustainability vocabulary and language across the organization, including the extended enterprise.
Governance	External compliance	Evangelize and spread sustainability successes and contribute to industry best practices.
	Corporate policies	Enable and comply with regulations and legislation. Require accountability for sustainability roles and decision making.

The organization should evaluate their current situation in relation to these nine capabilities to better understand how the capabilities can be developed and managed. The assessment is done by surveys and interviews, and it includes opinions from IT and business leaders and key stakeholders. The assessment

reveals the value placed on each capability, the overall vision and differences and similarities between stakeholder opinions. The overall maturity of the organization's SICT is an aggregate of the maturity levels of the nine building blocks. (Donnellan et al., 2011.)

Evaluating and managing SICT progress over time

When the initial assessment of the maturity level and the capability building blocks is done, the organization should have a clear view of their current capabilities and the key areas of ICT they need to develop. The results are needed to create short-term and long-term action plans for SICT. A yearly follow-up assessment should also be added to the overall IT management process so that the progress of the action plans can be monitored and the value that SICT brings can be measured. It is very important to agree on stakeholder ownership on different capability development areas. (Donnellan et al., 2011.)

The SICT-CMF is a framework for methodical assessment of an organization's sustainable ICT capabilities. The framework helps the organization to realize its current capabilities and shortages and offers a development path for the future. The maturity levels of sustainable ICT are divided into 5 levels from initial to optimizing, and the framework offers capability building blocks that form sustainable ICT when developed properly.

4 SUMMARY OF THE LITERATURE REVIEW AND DEVELOPMENT OF THE RESEARCH FRAMEWORK

The purpose of this literature review was to study and explain the concepts of smart tourism and green IT, as well as to highlight the environmental impacts stemming from both tourism activities and the existence of information technology. In addition, the purpose of the literature review was to build a framework for the empirical part of the thesis. In this chapter, the summary of the literature review is presented first and then, the construction of the research framework is portrayed.

4.1 Summary of the literature review

In the first chapter of the literature review (chapter 2) the idea of smart tourism was explored. The main concepts related to smart tourism were explained, the technological foundations of smart tourism were presented, and smart tourism destinations and their characteristics were described with examples. Then in chapter 2.3.3, the focus was shifted towards the development of smart tourism destinations. Therefore, the first chapter endeavors to answer two of the supporting research questions *"What is smart tourism and smart tourism development?"* and *"Which technologies and ICT solutions are used in smart tourism development?"*. In addition, a separate chapter was devoted for the impacts of tourism (chapter 2.4) to connect smart tourism to the other main topic of this research, green IT, and to bring forth the need for sustainable development in the tourism field.

Smart tourism was defined as all touristic activities that are informed, supported and completed by smart technology. Smart technology is used to create, manage and to deliver intelligent touristic services through information sharing and value co-creation. An important core function of smart tourism is data management: tourism relevant data is collected, processed and exchanged among stakeholders. The data enables companies and service providers to per-

sonalize their tourism services which improves service quality and the tourists' satisfaction. From the tourist's point of view, smart tourism manifests for example as mobile applications, personalized services, real-time information and efficient mobility in the destination. The technological foundation of smart tourism is based on the same technologies used in smart cities, the most notable ones being IoT (Internet of Things), cloud computing and End-User Internet service systems. The different technologies used in smart tourism create an interconnected infrastructure that consist of information systems, computing technologies, hardware, software, advanced analytics and network technologies.

Smart tourism destinations were defined as special cases of smart cities which aim to enhance mobility and the overall tourism experience, improve the efficiency of resource management, maximize the destination's competitiveness and customer satisfaction while demonstrating sustainability. The key aspect of smart tourism destinations is the integration of technology into the destination's physical infrastructure. The successful development of a smart tourism destination requires the components of traditional tourism and smartness which can be divided into hard and soft smartness. The components of traditional tourism are the 6 A's: attractions, accessibility, amenities, available packages, activities and ancillary services. Hard smartness refers to ICT or the technology used in the destination. Soft smartness includes innovation, social capital, human capital and leadership which are all needed in building a prolific smart environment. Creating a smart tourism destination requires inclusive ecosystem design that includes all the actors in the region in the development process.

The presented impacts of tourism were divided into environmental impacts and sociocultural impacts. The environmental impacts of tourism are substantial since tourism accounts for 5.2-12.5% of global warming potential. In addition, tourism uses a large amount of energy and water, generates a great deal of waste, leads to loss of biodiversity and destroys landscape. The sociocultural impacts affect the local population: cultures, values and heritage can be affected, modified or even destroyed by tourism. Tourism also causes traffic congestion and increases local prices of products, land and real estate.

In the second chapter of the literature review (chapter 3) the field of green IT was examined. The concept of green IT was explained, the environmental impacts of IT were recounted, and current green IT practices and approaches were presented. Then, the benefits of green IT were introduced and last, the most used green IT frameworks were presented. Therefore, the second chapter aims to answer the supporting research question *"What are green IT and green IT sustainability principles?"*.

Green IT was defined as sustainable and environmentally sound information technology. The main goal of green IT is to decrease the harmful effects on the environment by sustainable ICT, IT applications and practices. Green IT consist of three complementary dimensions that are all needed to achieve a sustainable economy. First dimension is the direct impacts which include greening the design, manufacturing, use and disposal of technology with minimal impact on the environment. These are also called the direct impacts of IT which stem

from the overall existence of IT. The second dimension is using IT and IT applications to support environmental sustainability in other business processes. IT is used indirectly as an instrument in decreasing negative environmental impacts of processes. This might include optimization, dematerialization, integration and substitution. These are also called the enabling impacts of IT. The third dimension contains using IT to create green awareness, endorsing green agenda and promoting green initiatives not only in the organization but also through the extended enterprise. These are also called the systemic impacts of IT. In addition to these three dimensions, Murugesan & Gangadharan (2012) have composed a holistic approach to achieving total environmental sustainability of IT. The holistic approach consists of six complimentary directions which are green design, green manufacturing, green use, green disposal, green standards and metrics and green IT strategies and policies.

In chapter 3.1.1 the environmental impacts of IT were presented. ICT accounts for 2% of global CO2 emissions which is equal to the amount caused by the aviation industry. The manufacturing of IT consumes an enormous amount of energy, raw materials, chemicals and water and produces toxic waste. Although IT can reduce environmental impacts in many fields, IT itself has significant negative impacts on the environment. These impacts can be reduced by green IT practices and approaches which include for example PC power management, energy efficient cooling, green data center design and server virtualization. Green design, green manufacturing, green use and green disposal minimize the energy consumption, usage of raw materials and chemicals and decreases the amount of greenhouse gas emissions. Not only does green IT benefit the environment, but also organizations. Adopting green IT principles and practices in the organization delivers competitive advantage and economic benefits. Since purchasing decisions are increasingly influenced by ethical concerns and investors are demanding more from companies in the environmental sense, green IT offers a way to answer these demands. Green IT practices and approaches lead to energy efficiency which decreases the company's overall expenses, hence leading to economic benefits.

In chapter 3.3 the most commonly used green IT frameworks were presented. The frameworks included were the OECD Green IT Framework (OECD, 2010), the G-Readiness framework by Molla et al. (2008) and The Sustainable ICT-capability maturity framework (SICT-CMF) by Donnellan et al. (2011). The first model is a fairly simple categorization of IT's environmental impacts and the other two are frameworks that measure readiness and maturity of green IT sustainability.

4.2 Development of the research framework

In order to answer the main research question *"How are green IT sustainability principles incorporated in Finnish smart tourism destination development and its ICT solutions?"* a theoretical framework for empirical research is needed. The theo-

retical framework will be developed based on the literature of green IT. Since answering the research question requires a holistic perspective, all the green IT models and frameworks presented in the literature review will be combined into the research framework. Many similarities can be found between them which will be reconstructed into suitable themes for the research framework. The frameworks, models and approaches assessed in the development of the theoretical framework are:

1. Green IT Dimensions (Murugesan & Gangadharan, 2012, p. 5), chapter 3.1
2. Holistic Approach to Greening IT (Murugesan & Gangadharan, 2012. p. 7.), chapter 3.1
3. The OECD Green IT Framework (OECD, 2010), chapter 3.3.1
4. The G-Readiness Framework (Molla et al., 2008), chapter 3.3.2
5. The Sustainable ICT-capability maturity framework (SICT-CMF) (Donnellan et al., 2011), chapter 3.3.3

These frameworks and models were selected because they are central in the green IT field and are used commonly even today in assessing organizations' sustainable ICT, preparedness to adopt green IT or state of IT's sustainability.

The first notable similarity can be found between Green IT Dimensions and the OECD Green IT framework. The Green IT Dimensions seem to be compatible with the levels of OECD Green IT Framework. The similarities are presented in Table 3.

Table 3. Comparison of Green IT Dimensions and the OECD Green IT Framework

Level	Green IT Dimensions	OECD Green IT Framework
1	Greening IT systems and usage: designing, manufacturing, using and disposing technology, systems and software efficiently with minimal impact on the environment.	The direct impacts of IT: impacts that result from the existence of IT. These impacts are generated by manufacturers, suppliers, intermediaries, goods producers and consumer users of ICT.
2	Using IT to support environmental sustainability (indirect): supporting and assisting enterprise-wide initiatives and processes with the use of IT.	The enabling impacts of IT: the effects that result from the use of IT applications that help to reduce negative environmental impacts of business and social processes.
3	Using IT to create green awareness, endorsing green agenda and promoting green initiatives among stakeholders.	The systemic impacts of IT: wide-spread phenomena such as behavioral change, process change, promoting green agenda and creating green awareness. Non-technological factors that are related to culture, behavior and attitude that are generated by IT applications, firms, people and processes.

The only difference between the two frameworks is the viewpoint: The Green IT Dimensions declare what green IT can do, and the OECD levels describe what sort of impact does IT have. The content is nevertheless the same: the first level focuses on the direct impacts related to the existence of IT, impacts that arise from the design, manufacturing, use and disposal of IT. The second level focuses on using information technology as a tool to decrease other processes' environmental impact. The last level concentrates on green awareness, green agenda, behavioral change and non-technological factors. Because these three levels are so heavily weighted in green IT literature, the levels are chosen as three themes in the research framework. They will be named direct impacts of IT, enabling impacts of IT and systemic impacts of IT.

Next, if the focus is on the theme *direct impacts of IT*, many similarities can be found with the other frameworks. The first four parts of the Holistic Approach to Greening IT correspond with direct impacts of IT. These are green design, green manufacturing, green use and green disposal. Also, one building block from The Sustainable ICT-capability maturity framework focuses solely on the direct impacts of IT: operations and life cycle (all the building blocks for SICT-CMF are depicted in Table 2). The description for this building block is "source, operate & dispose ICT according to sustainability objectives" which corresponds with the direct impacts of IT. The G-readiness Framework has two factors that match this theme: practice and technology. Practice includes the measurement of how the organization's policies are being turned into actions. There are three categories of practices: green IT sourcing practice, green IT operations and services practices and green IT end of life management practices. Sourcing refers to how environmental issues are taken into consideration in purchasing decisions. It includes valuating the supplier's environmental behavior and choosing to purchase from green vendors. In other words: is the purchasing done from companies that *manufacture* their products in green manner? Green IT operations and services practices refer to the *use* of information technology. The operational actions aim to reduce power consumption in many ways. Green IT end of life management practices measure how IT is *disposed* or possibly reused, recycled or refurbished. The technology factor includes technological indicators, such as green business infrastructure, green power sources, server virtualization and IT recycling, which are all compatible with the direct impacts of IT. All the reference frameworks examined included green design, manufacturing, using and disposing as in the direct impacts of IT. Therefore, it will be one theme in the research framework.

The enabling impacts of IT has a similar counterpart in SICT-CMF: ICT-enabled business processes. The building block is defined "provisions for ICT systems that enable improved sustainability outcomes across the extended organization" which matches the meaning of the enabling impacts of IT. The systemic impacts of IT also have a counterpart in SICT-CMF: external compliance which is defined as "evangelize sustainability successes and contribute to industry best practices". This means advertising sustainability successes and cre-

ating green awareness. Contributing to industry best practices helps to create green awareness and spreads behavioral change. Since the enabling impacts and the systemic impacts of IT occur in most of the frameworks in some form, they will be themes in the research framework.

After forming the before mentioned three themes, there are still important aspects left in the reference frameworks that do not fit into these three themes. In the G-readiness Framework, attitude is presented as an important factor. Attitude is said to measure how interested and invested the leaders are in concerns related to the use of IT. It is discovered that emotional appeal is a stronger factor than logical reasoning in influencing people to act. Molla et al. (2008) state that the extent of actions taken to tackle environmental concerns depends mostly on the leaders' personal attitudes on environmental concerns. Whether or not a person supports the green agenda is dependent on subjective motivation and subjective capabilities. Since personal attitudes have a significant role in reducing environmental impacts in organizations, it is important to include it in the research framework. The SICT-CMF also has building blocks that are related to people and culture: adoption and language. Adoption includes embedding sustainability principles across the organization and its ICT, and language means defining, communicating and using common sustainability language and vocabulary across the organization, including the extended enterprise (other stakeholders, suppliers, partners etc.). Since the cultural factors and attitude are important in supporting the green agenda, they are added into the research framework as a combined theme: attitude, people and culture.

Strategies and policies are included in SICT-CMF, the Holistic Approach to Greening IT and the G-Readiness Framework. In SICT-CMF, the theme is present in the building blocks alignment and objectives. The organization's sustainable ICT (SICT) strategy must be aligned with the business strategy and business sustainability objectives. The organization should also define clear objectives for sustainable ICT. According to the Holistic Approach to Greening IT, green IT strategies and policies are a key component in greening IT. They are benefitted from the most, if they are aligned with business strategies and practices. In the G-Readiness Framework, policy readiness measures how commonly sustainable policies are developed throughout the organization and its value chain. Policy readiness is divided into three value chain areas: IT sourcing policy, IT operations and services policy and IT end-of-life policy. The policies are made as guidelines for future actions and are designed to be sustainable. Since strategies and policies are a key component of sustainable ICT on organizations, strategy and policy will be added to the research framework as one of the themes.

The last section of the frameworks that has not been yet addressed, is governance. It is included in SICT-CMF, the Holistic Approach to Greening IT and the G-Readiness Framework. In the G-Readiness Framework governance stands for management of implementing green IT. It includes defining roles and responsibilities, accountabilities and control for IT initiatives. Implementing green IT requires an ingrained management infrastructure. In the Holistic Approach

to Greening IT, the direction *standards and metrics* is related to governance. According to Murugesan & Gangadharan (2012. p. 7.) green standards and metrics are needed for measuring, comparing and benchmarking different sustainability related initiatives, products and services. Efficient governance requires standards to comply with and metrics to measure with. SICT-CMF has two building blocks that appear to belong under the governance theme, performance and reporting and corporate policies. Performance and reporting include reporting and demonstrating the organization's progress against set objectives. Corporate policies include requiring accountability for sustainability roles and decision making and enabling and demonstrating compliance with laws and regulations. These will be combined into the research framework as a theme named governance.

Table 4 illustrates a literature-based framework that will be used to study how green IT sustainability principles are incorporated in smart tourism development. There are six main themes derived from the green IT literature: attitude, people and culture, direct impacts of IT, enabling impacts of IT, systemic impacts of IT, strategy and policy and governance. Each of these themes contains specific relevant topics derived from the reference frameworks which can be used to describe how the theme manifests in the smart tourism development projects. The topics are briefly explained in the last column of the table.

Table 4. Research framework for the empirical research based on the literature review

Theme	**Topics of the theme**	**Definition**
Attitude, people & culture	Subjective motivation	Whether or not the person supports the green agenda personally. Reasons for supporting the green agenda.
	Subjective capabilities	The person's own perception of whether or not his/her actions have an effect on the environment.
	Language	Using common sustainability vocabulary and language across the organization.
Direct impacts of IT	Green design	Taking into account the impacts that result from the existence of IT. Minimizing the impact that is generated by designing, manufacturing, using and disposing technology, systems and software.
	Green manufacturing	
	Green use	
	Green disposal (3 R's: reuse, refurbish, recycle)	

(continues)

Table 4 (continues)

Enabling impacts of IT	The use of IT to support, assist and leverage other environmental initiatives	The effects that result from the use of IT applications that help to reduce negative environmental impacts of different business and social processes.
Systemic impacts of IT	Creating green awareness and promoting green agenda	Spreading and advertising sustainability successes and creating green awareness extensively.
	Behavioral change and process change	Executing actions that shape people's behavior towards greener solutions. Executing actions that shape processes towards a sustainable direction.
Strategy & Policy	Objectives	Defining objectives for sustainable development of ICT.
	Strategy and alignment	Defining a strategy for sustainable development for ICT and aligning it with the business strategy.
	Policy	Defining general policies regarding the sustainability of ICT solutions, such as procurement policy, use policy, disposal policy etc.
Governance	Standards & Metrics	Defining green standards and metrics for measuring, comparing and benchmarking different sustainability related initiatives, products and services.
	Roles, responsibilities, accountabilities and control	Defining roles and responsibilities for the sustainable development of ICT. Requiring accountability for sustainability roles and decision making.

5 EMPIRICAL RESEARCH

This chapter presents the implementation of the empirical part of the master's thesis. First, the research objective and the chosen research method are described. Then the data collection method is explained and lastly, the data analysis is described.

5.1 Research objectives

The purpose of this study is to examine how the sustainability principles of green IT are present in projects aiming at the development of smart tourism. Tourism is a conflicting topic, as it is the main source of income for many countries and cities, but at the same time it produces a significant amount of negative environmental impacts. Smart tourism is an advanced form of tourism where all tourism-related activities are supported by information technology. Green IT can offer practices and approaches that assist in reducing the negative environmental impacts of tourism. Green IT approaches can improve the sustainability of the technology that supports smart tourism and offer enabling solutions through other processes that reduce the extent of the negative impacts of tourism. As information technology is the most important component of smart tourism, it is logical to examine the sustainability of smart tourism development through the theories of green IT. The study was focused on exploring smart tourism development projects from within: the purpose is to examine how sustainable the development of smart tourism is from the green IT perspective. The following research question was defined for the study based on the set goals:

- How are green IT sustainability principles incorporated in Finnish smart tourism development and its ICT solutions?

Because of limitations to time and resources, the study was limited to the development of Finnish smart tourism. In addition, Helsinki, the capital of Fin-

land, was selected as the winner of EU's inaugural European Capital of Smart Tourism competition (Good News from Finland, 2018) which renders the topic relevant in Finland at present.

5.2 Research method

Qualitative research was chosen as the research method. Qualitative research is best suited to examine this research question, as this subject has not been studied in Finland before. Qualitative research was selected as the research method after carefully comparing qualitative and quantitative methods. According to Hirsjärvi, Remes ja Sajavaara (2016, p. 161) the basis for qualitative research is the description of real life. In qualitative research, the aim is to explore the selected subject as comprehensively as possible. The objective is to find and reveal facts instead of trying to verify existing claims. (Hirsjärvi et al., 2016, p. 161). The purpose of this study is to describe the state of sustainability of actual smart tourism development projects without controlling the circumstances, which is why the qualitative approach is suitable.

In qualitative research, the analysis is often performed inductively. The goal of the research is to reveal yet uninformed and sometimes unexpected facts. Therefore, the objective is not to test hypotheses but to examine the research material in detail and in a multilateral way, without preconceptions or specific expectations. (Hirsjärvi et al., 2016, p. 164.) Inductive analysis might bring forward unexpected and important information. The researcher does not decide what is important, but the gathered material will reveal important facts.

In qualitative research, the research materials are usually collected in natural situations and the source of knowledge is usually a human being. (Hirsjärvi et al., 2007, p. 164.) The key data collection methods in qualitative research are interviews, observation, biographies (Hirsjärvi et al., 2007, p. 164) and information from various documents (Tuomi & Sarajärvi, 2018). These data collection methods reveal the individual's personal views and opinions on the studied subject.

In qualitative research, understanding the research subject is paramount, and research is not always carried out on account of generalization (Hirsjärvi et al., 2016, p. 164). Preliminary hypotheses are typical in quantitative research (Hirsjärvi et al., 2016, p. 140). It is not sensible to set any preliminary hypotheses for this research topic, as the purpose of this study is to map and describe how the sustainability principles of green IT are present in Finnish smart tourism development projects. According to Hirsjärvi et al. (2016) the purpose of research can be mapping, descriptive, explanatory and predictive, from which mapping and descriptive are commonly related to qualitative research. The purpose of this study is to be mapping and descriptive and in no way explanatory or predictive. The purpose is to describe the state of sustainability of the development projects with certain themes. The key objective is to map the current state of sustainability without trying to explain why they are in a particular

state or predicting what will be in the future. There are no presumptions guiding this research, but the objective to examine and describe. Therefore, the purpose of this research is better suited to qualitative research.

5.3 Data collection

Interview, which is the main data collection method of qualitative research (Hirsjärvi et al., 2016, p. 205), was chosen for this research. In qualitative research, human beings are favored as the source of information (Hirsjärvi et al., 2016, p. 64), and interviews may lead to informal and profound discussions that reveal matters that might not come forth by other means (Hirsjärvi & Hurme, 2015, p. 11). In an interview, the interviewer is in direct linguistic interaction with the subject (Hirsjärvi et al., 2016, p. 204), which brings many benefits. The greatest benefit of an interview is flexibility: interviews can lead the data collection to a more accurate direction and the interview questions can be adjusted towards relevant topics according to the situation (Hirsjärvi et al., 2016, p. 205). Interview responses are also easier to interpret than, for example, questionnaire answers, as the interview often reveals the motive of the answer.

The purpose of this study is to observe the state of sustainability in Finnish smart tourism development projects from the perspective of green IT, in other words, to discover how sustainable these development projects are according to the green IT literature. In order to discover this, it is essential to know the real opinions of the people who work in these projects, which is why the best approach is a confidential conversation. The advantage of an interview is that the interviewee can express himself freely in a conversational style, making it more likely that real opinions are revealed (Hirsjärvi et al., 2016, p. 205). Since the research topic is one that has not been studied in Finland before, an interview can provide the most relevant information comprehensively. Since the research question is relatively open and the purpose of this study is to be mapping and descriptive, it is known in advance that the answers will be broad and comprehensive. In such circumstances, the interview method is the most suitable one for obtaining information. Talking with the interviewee also allows the interviewer to clarify and deepen the received answers with possible additional questions, which, for example, is not possible when conducting a survey. (Hirsjärvi et al., 2016, p. 205.) A survey is a possible data collection method in qualitative research, but it was not chosen for this study because interviews provide the flexibility needed to study this research question. In addition, interviews might provide more accurate answers, since the interviewer can ensure that the interviewee has interpreted and understood the questions correctly. An interview also might provide information on topics and areas that cannot be objectively tested or predetermined and are unexpected, which is not possible when conducting a survey. (Hirsjärvi & Hurme, 2015, p. 36.) Observation would not have been suitable as a data collection method, as some of the research questions were related to a past time.

The semi-structured interview was chosen as the interview type for this study. The semi-structured interview is an interview method in which one aspect of the interview is predetermined but not all. For example, the interview questions may be the same for everyone, but their order may vary depending on the interview. Questions may also be predefined, but their wording may be varied in the interview. (Hirsjärvi & Hurme, 2015, p. 47.) The semi-structured interview type was chosen because in qualitative research, it is favorable to use an incomplete interview script, because the interview requires openness, flexibility and improvisation, and in addition, the interviewer should be ready to explore the most interesting findings further in the interview (Myers & Newman, 2007). The semi-structured interview method used in this study is called a focused interview (also referred to as 'general interview guide approach' in the research literature). A focused interview is characterized by the fact that the interview focuses on certain predefined topics or theme areas, but the exact form and order of the questions may be undefined. (Hirsjärvi & Hurme, 2015, p. 47.) In this study, the topics of the interview were based on the themes of the research framework developed in chapter 4. According to Schultze & Avital (2011), using a framework as the basis of the interview structure aids the interviewer in leading the interview meaningfully and helps to obtain detailed and information that is rich in material.

In qualitative research, discretionary sampling is generally used, meaning that the people interviewed are appropriately selected (Hirsjärvi et al., 2016, p. 164; Hirsjärvi & Hurme, 2015, p. 59). Since the purpose of this study is to explore how the sustainability principles of green IT are present in the development of smart tourism in Finland, it is appropriate to select people who are involved in Finnish projects aimed at developing smart tourism. Since the development of smart tourism is usually related to the development of smart cities, it was decided that the employing entity of the selected people could also be an entity that is oriented in developing a smart city. Direct development projects for smart tourism are scarce, therefore the employing entity of the interviewees could be a city, a municipality, a company etc. People working in smart tourism development projects were searched and they were initially contacted by email. Snowball sampling was also used partially since interviewees were asked to suggest other people who might be suitable for the interview (Hirsjärvi & Hurme, 2015, p. 60). In order to gain as versatile information as possible about the state of sustainability, the goal was to acquire interviewees from different positions in the projects. The criterion was that the person is either working in the project now or has been working in one during the last year. The aim was to get interviewees as widely as possible across Finland from different cities.

In qualitative research, it is difficult to determine the optimal number of interviewees because the purpose of the study is not to search for average connections or statistical regularities (Hirsjärvi et al., 2016, p. 181). The main goal of the study is to understand the research subject comprehensively. The targeted number of interviewees was defined at 12-15 people. Hirsjärvi & Hurme (2015, p. 58) state that the typical number of interviewees in qualitative research is

currently 15. The target amount was influenced by time constraints, as interviews take much more time, than for example, conducting a survey. In the end, 10 people agreed to the interview. The amount was considered to be sufficient to obtain versatile information, as the appropriate amount is always determined definitively by the purpose of the study (Hirsjärvi & Hurme, 2015, p. 58).

The interviewees were contacted by email and the actual interviews were conducted as individual interviews over the telephone. As the interviewees were from different cities, this was found to be the most cost-effective and sustainable choice. Videoconference via Skype was the first initial means of interviewing, but it was discarded as the Skype for Business and Skype for consumers are not compatible. It was decided that the interviewees should not be asked to create a consumer account for the interview since the interview should be as effortless as possible for the interviewees. The interview was conducted in Finnish as it was the mother tongue of the respondents. Answering questions in a foreign language might have caused the interviewees some difficulties in expressing themselves, and the answers might have been more limited due to the possibly restricted vocabulary. The length of the interviews ranged from 26 minutes to 41 minutes and all interviews were recorded with the permission of the interviewee. As it was important to discover the interviewees' true opinions comprehensively and honestly, the individual interview was best suited for this study. In this way, the influence of other people and other disruptive factors on responses were minimized. The interviewees were promised full anonymity, meaning that their personal information that they could be recognized from would not be linked to the material at any time.

The interview questions in English are presented in Table 5. The used Finnish interview questions are presented at the end of the thesis, in appendix 1. They were translated from the original English questions. The questions were based on the framework outlined in chapter 4. Otherwise the interview frame follows the structure of the research framework, but two questions have been added to the beginning concerning the interviewee's current occupation. The questions were added in order to make the start of the interview as easy and natural as possible for the interviewee. In addition, knowing the interviewees job title and its description might help to interpret the answers more comprehensively. After these two questions, the interview frame follows the structure of the research framework. The themes of the interview are background information, attitude, people and culture, direct impacts of IT, enabling impacts of IT, systemic impacts of IT, strategy and policy and governance. At least one question was developed for each topic within the theme. Some further questions were added for a few of the questions depending on the answer in order to collect the most comprehensive answers as possible.

Since the interview type was semi-structured, it allowed to ask improvised but relevant additional questions in some of the interviews. In most of the interviews, the questions, concepts and related terms were explained in more detail to the interviewee. Not all questions were asked in the interviews, since

they were not relevant in all projects, or the interviewee had no knowledge on the subject. The order of the questions was also changed if necessary.

Table 5. The interview questions based on the research framework

Theme Topics	**Questions**
Background information Job title Job description	1. What is your job title? 2. Would you describe what your job title entails?
Attitude, people & culture Subjective motivation Subjective capabilities Language	3. Does the state of the environment, different environmental impacts and climate change worry you personally? 4. Do you consider it important to consider environmental impacts when designing ICT solutions for smart tourism development? 5. Do you believe that you can influence the state of the environment through your actions in your job? How? 6. Does your working environment have communication and vocabulary related to sustainable development?
Direct impacts of IT Green design Green manufacturing Green use Green disposal (3 R's: reuse, refurbish, recycle)	7. How do green design, manufacturing, use and disposal appear in your project? 8. In purchasing decisions, do you take into account the environmental friendliness of the producer? Is the use of IT energy efficient? 9. Does your project strive to reuse or recycle technology? Is the disposal of technology handled with minimal environmental impact?
Enabling impacts of IT The use of IT to support, assist and leverage other environmental initiatives	10. Does your project focus on ICT systems and solutions that help reduce negative environmental impacts in different business processes?
Systemic impacts of IT Creating green awareness and promoting green agenda Behavioral change & process change	11. Do you do any actions in your development project that increases or creates environmental awareness? How? 12. Do you believe that the ICT solutions used in your development project will generate behavior or process change? How?

(continues)

Table 5 (continues)

Strategy & Policy Objectives Strategy & alignment Policy	13. Have you set objectives for sustainable development of ICT in your development project? 14. Do you have a strategy for sustainable development of ICT? If you do, has it been aligned with the business strategy? 15. In your development project, have you defined general policies regarding the sustainability of ICT solutions, such as procurement policy, use policy, disposal policy etc.
Governance Standards & metrics Roles, responsibilities, accountabilities and control	16. Do you have any standards or metrics to help you monitor the sustainability of your ICT solutions? 17. Have you defined roles and responsibilities of monitoring and implementing sustainable development?

5.4 Data analysis

As the study was conducted with a qualitative research method, a qualitative analysis was chosen as the method for analysis. In qualitative analysis, the researcher uses either inductive or abductive reasoning. In inductive reasoning, the research material is central, and new facts are being sought from the material. In abductive reasoning, the researcher has some initial theoretical ideas that he/she tries to verify by the interviews. (Hirsjärvi & Hurme, 2015, p. 136.) The inductive reasoning was chosen as the method of reasoning for this study as this study does not seek to prove any hypotheses but endeavors to find descriptive new information. According to Hirsjärvi and Hurme (2015, p. 136), the typical features of qualitative analysis include conduction of the analysis already at the interview stage, storing the interview materials in written form and using varying techniques for analysis, since there is no one true analysis technique. As the researcher usually conducts the interviews, the researcher is able to draw conclusions during the interviews, finding connections and specialties at the interview stage. This study sought to find similarities from the interviews in the interview stage.

The material obtained during the interviews can be interpreted in two ways: either the interviews are transcribed into a written form, or conclusions are drawn directly from the recorded material, for example by listening to recordings (Hirsjärvi & Hurme, 2015, p. 138). In this case, the material was transcribed into written form. According to Hirsjärvi and Hurme (2015, p. 138), transcribing is more common when there are several interviews and their duration is long. According to Hirsjärvi et al. (2016, p. 222), the interviews are transcribed into written form either from word to word or selectively, for example, by themes. In this study, the transcription was done from word to word to en-

sure that nothing potentially meaningful would be lost. Each interview was transcribed into its own text file. A program was used to change the speed of the audio track, so that in unclear sections, the speech could be slowed down to facilitate the understanding. This allowed the interviews to be written down as accurately as possible. The transcriptions of the interviews were made as soon as possible after the interview, so that some conclusions could be drawn from the transcribed material at the interview phase. When all the transcriptions were written, they were read through carefully and then, redundant words, repetitions and non-essential things were removed from the text. This was done carefully to save all relevant material on the subject. In addition to this, all the elements that might have led to identify the interviewee were removed from the text in order to maintain their anonymity.

After the transcription phase, the actual analysis began. According to Hirsjärvi & Hurme (2015, p. 144), the analysis of the material consists of four phases: reading, categorization or coding, finding connections and reporting. The analysis was therefore started by reading: the transcribed interview materials were read multiple times. Orientating oneself with the materials by reading them in depth several times can help find preliminary connections in the material and bring forth interesting questions. The reading phase was followed by classification, which is a very important part of the analysis according to Hirsjärvi & Hurme (2015, p. 147), as it creates a framework for later interpretation and summarization of the material. The way in which the material is categorized must be well-founded, because the categories must have some connection and substantial similarities (Hirsjärvi & Hurme, 2015, p. 147). The material can be categorized by the research problem or research method, concepts, theories or by intuition of the researcher (Hirsjärvi & Hurme, 2015, p. 148). Since the interviews were conducted as focused interviews (focused on certain themes), it is natural that the material was categorized according to the themes, as each theme is concentrated on certain subject with its own purpose. Thus, the written material was reorganized so that a text document was created for each theme, in which the answers corresponding to the theme for each interview were attached. The themes of the categorization were attitude, people and culture, direct impacts of IT, enabling impacts of IT, systemic impacts of IT, strategy and policy and governance. A table was also created to facilitate the interpretation, where interview questions and the interviewees' answers were added by theme.

According to Hirsjärvi & Hurme (2015, p. 149), categorization is usually followed by finding connections. This means finding regularities and similarities between the answers. In addition, abnormalities and special cases are usually found from the research material. In this study, attempts were made to find connections already in the transcription and categorization phases. To facilitate finding the connections, the text documents were printed as paper versions by the themes. The paper versions were read again attentively, and color coding was used to mark similarities, connections and abnormalities. Interesting and notable statements were underlined. The compiled table was updated every

time new connections, similarities or abnormalities were found in the material. The results of the analysis are reported in the next chapter.

6 RESULTS

The results of the empirical research are presented in this chapter. First, the background information of the interviewees is presented, and the smart solutions related to smart tourism development are described. The results are then presented according to the order indicated by the research framework created in chapter 4: attitude, people and culture, direct impacts of IT, enabling impacts of IT, systemic impacts of IT, strategy and policy and finally, governance. In some of the themes, some results are also reported in quantitative terms in addition to qualitative analysis, in order to facilitate the understanding of the results. The citations used to support the analysis have been translated from the interview language, Finnish, to English.

6.1 Interviewees background information

The sample of the study consists of 10 individuals, who were selected on a discretionary basis. The interviewees were obtained from three Finnish cities: Helsinki, Tampere and Jyväskylä. The interviewees all work in projects in which the development of smart tourism is either the goal of the project, or a part of the project. The job titles of the interviewees are presented in Table 6.

The projects of the interviewees have several different smart tourism related ICT solutions that are either completed or possibly in the planning phase. These solutions are presented in Table 7.

Table 6. Job titles of the interviewees

Interviewee	**Job title**
Interviewee 1	Senior Specialist Business Intelligence
Interviewee 2	Project Manager
Interviewee 3	Postdoctoral Researcher
Interviewee 4	Project Manager
Interviewee 5	Project Researcher
Interviewee 6	Community Manager
Interviewee 7	Project Manager
Interviewee 8	Digital Development Director
Interviewee 9	CEO
Interviewee 10	Developer

Table 7. Smart tourism related ICT solutions of the interviewees' projects

Interviewee	**Project's smart tourism ICT solutions**
Interviewee 1	Digital tourism information services, such as an application with route guide, public transport schedule and other services (digital library card, booking possibilities) and smart information screens in the city with public transport schedules, map, information on the tram construction etc.
Interviewee 2	Digital co-solutions and applications that guide mobility, transport and consumer behavior (in the planning phase).
Interviewee 3	Conceptualizing and piloting digital co-solutions related to mobility and food chains, such as shared refrigerator spaces.
Interviewee 4	Smart mobility solutions such as self-driving busses. Formerly worked on a route guide application that also included public transportation schedules and booking.
Interviewee 5	Digital solutions that direct people's behavior and consumer habits in the tourist destination area (in the planning phase).
Interviewee 6	Developing a smart city model area with energy solutions, smart everyday services and smart mobility services. For example, sharing parking spaces and offering electric cars with smart locks for public use.
Interviewee 7	Digital guide application development, smart information screens, an event application for even organizers, service providers and event goers with route guides, event information and maps. Also, a city application with information, tours, sites, public transportation information and booking and service vouchers. Also, a guide app with visual guiding.
Interviewee 8	Nationwide digital roadmap for digitalization of Finnish tourism industry. The development of a nationwide data warehouse between tourism companies and service providers, data collaboration.
Interviewee 9	An application that allows private parking space owners to rent their parking space forward. Also, car sharing (in the planning phase).
Interviewee 10	An application that brings together different tourist attractions and sites of the nearby area.

6.2 Attitude, people and culture

This chapter presents the results for the theme attitude, people and culture. The theme has three main topics: subjective motivation, subjective capabilities and language. The results are presented in that order.

6.2.1 Subjective motivation

Subjective motivation of the interviewees was studied by asking them if the state of the environment, different environmental impacts and climate change worried them personally. In addition, they were also asked whether they believed that it is important to consider environmental impacts in designing ICT solutions for smart tourism development. All of the 10 interviewees replied that environmental factors worry them to some extent.

> "Yes. I am strongly in favor of the fact that current consumption habits, as they are, cannot be continued because the earth will not stand it. In addition, untreated natural resources are diminishing, and we must be able to develop ways to move, serve and consume sustainably." – Interviewee 7

> "Yes, it worries me constantly, in personal life and when it comes to work. I think that nobody can afford to think otherwise any longer." – Interviewee 10

Two of the interviewees, 6 and 3, stated that environmental factors worry them very much and have caused concern for a long time.

> "Yes, very much, and has worried for years. I have been concerned about these issues all the more just through that in this academic work, for example in terms of traveling to conferences, it emerges very concretely that I'm flying somewhere and producing climate or greenhouse gas emissions." – Interviewee 3

> "Yes, it worries me quite much, and it's my motivation to be in this type of a job." – Interviewee 6

Two of the interviewees, 1 and 5, replied that the environmental factors probably worry them, but not as strongly as the other interviewees.

> "Well yes, probably somewhat, of course. Of course, it has been so prominently featured for some time already that it can't be avoided." – Interviewee 1

> "Well, let's say that it probably worries me, but my attitude is that you should focus on what you can do. The worrying doesn't seem to carry things forward, this project is also trying to focus more on solutions than on those concerns." – Interviewee 5

Some of the interviewees revealed that environmental concerns were the reason they chose their line of study or their current career path.

> "Well yes, it worries me more day by day. Sure however, I ended up studying environmental technology precisely for the reason that I would like to build a more comfortable future for posterity and for my own descendants." -Interviewee 1

> "Yeah, of course, and in a way my own career choice is partly due to this kind of consumption hysteria that I dislike... My background is a designer, and I haven't had interest in producing just goods but rather some kinds of services. It has led my career choice and job choices." – Interviewee 4

Interviewee 8 was also worried about the environmental concerns and brought up the dissonance between sustainability and the tourism industry.

> "But, of course, there is a contradiction in this whole tourism industry that when people fly from one side of the globe to the other, it's not very sustainable. Yes, this is an all-time topic in the field, how to deal with this contradiction." – Interviewee 8

The interviewees were also asked whether they believed that it is important to consider environmental impacts in designing ICT solutions for smart tourism development. All but one of the ten interviewees answered that they regard it important to consider environmental impacts in designing ICT solutions for smart tourism. The interviewee who did not consider it to be as important as the other interviewees, argued it as follows:

> "I haven't quite thought about it like that, comparing different ICT projects, so I haven't been aware of the comparison between them. It is usually more like digitalization versus preserving old ways of doing things, it's somehow more interesting and it has more achievable benefits for the environment and human behavior." – Interviewee 4

Two of the interviewees, 2 and 5, considered it highly important to take the environmental impacts into account when designing ICT solutions for smart tourism development.

> "It is very important, if these solutions can lead the development to a more sustainable direction. In my opinion, it must always be taken into account in it, and to think about the alternatives so that... I find it hard to see that any digital solutions could no longer be done in isolation from building sustainable development and a sustainable future." – Interviewee 2

> "Yes, I would say that at this stage it is in the top 3 with usability and others." – Interviewee 5

Some of the interviewees considered it to be important but admitted that it is not always present, or it does not come to mind when designing ICT solutions.

> "Of course, I think it's important, but there's always the fact that is it always remembered when planning, so it can be left in the background. Well, perhaps, it's not always consciously involved." – Interviewee 3

> "Well I think it's really important, maybe it has not been always as visible as it could be, the environmental perspective. We may now have a stronger environmental focus, also through this carbon neutrality theme, that it has gotten stronger in recent years." – Interviewee 6

Two of the interviewees, 8 and 10, stated that digital development and sustainability should always be considered together.

> "They go hand in hand, both digital development and sustainable development, they are the strategic cornerstones of our tourism development, in all our work they must be taken into account, together." – Interviewee 8

> "Yes, I find it important. Tourism has so many drawbacks and negative effects on the environment that it seems futile to even develop tourism if it is not done in a sustainable way." – Interviewee 10

On the basis of the responses from the interviewees, one can conclude that environmental concerns are common and considering them is seen as important when designing ICT-based solutions for the development of smart tourism. All of the interviewees replied that environmental concerns worry them and some stated that it has led them towards their current career. All but one of the interviewees regarded it important to consider the environmental impacts in designing ICT solutions for smart tourism development. It is evident, that the current state of the climate worries people.

6.2.2 Subjective capabilities

Subjective capabilities, meaning whether or not a person feels that their actions have an effect in the environmental sense, were studied by asking the interviewees if they think that they can influence the state of the environment through their actions in their job. Most of the interviewees, 9 from all 10 interviewees, answered that they believe their actions have an influence to some extent. Only one of the 9 thought that they definitely can influence the state of the environment.

> "Well yes, surely, I can, my role is not in the sustainable tourism development side, that's my colleague's, but in general it feels that in these jobs, in a government organization, it has an influence on that field. There is a chance to speak at seminars all the time and to bring out important things, so in that sense, yes." – Interviewee 8

Most of the interviewees, 8 from 10, answered that they think that they have some influence on the environment through their actions in their job. Most of them suggested that their influence is somehow limited or restricted.

> "Well yes, something at least, but of course, the possibilities are limited." – Interviewee 2

> "As a small part of the whole, certainly yeah. All the projects we have, all of them are designed to solve the world's and cities' problems, and the environment is one big theme in many of them." – Interviewee 4

Almost half of the interviewees, 4 from 10, said that they wish that their actions would have an effect.

> "I hope so at least, but the fact that is there really, it will have to be seen, there's no way to know yet. But yes, one of our areas is not only to develop and evaluate these different solutions, but also create guidelines and criteria for the actors in the area for later, so in that sense I might have an influence." – Interviewee 3

> "Yes, there is some effect, I think. Difficult to say how much or how, but I certainly hope that there is." – Interviewee 10

Only one of the interviewees thought that their personal contribution does not have an influence on the environment.

> "Well let's say that I might hope so and we strive towards it, but you'll have to remember that in these projects the decisions are made by bigger players. The final result, which solutions are being put to use, well let's say that my influence is quite small. But I do not think that my personal contribution here has quite an enormous weight, however." – Interviewee 5

Based on the interviews, it can be said that most of the interviewees feel that their actions in their jobs may have some effect on the environment, but they are not convinced that the impact would be significant. Even though they feel that there is some effect, they feel that it is restricted or limited in some way. Almost half of the interviewees stated that they wish for their actions to have an influence on the environment. Only one of the interviewees stated that they do not believe that their own personal actions would have an influence.

6.2.3 Language

Language (and through that, culture) was studied by asking the interviewees if their working environment had communication and vocabulary related to sustainable development. Most of the interviewees, 9 out of 10, stated that sustainable development can be often found in conversations and in the vocabulary used in the workplace.

> "It is quite naturally in there, as I said, most of the projects are related to the topic so it's pretty common for us. In working sense, it is there from the technology development point of view, but I don't know how much people are interested in the environmental theme in their own activities." – Interviewee 4

> "Well let's say that there is a lot of that. It's a pretty good mashup of business talk and environmental talk. It is there, but even in this case, I feel that it doesn't override

> the business talk, so I would say that they are pretty balanced, that there is an equal amount of both. But constantly it is there, however." – Interviewee 5

One of the interviewees, 9, said that sustainable development comes forth in conversations sometimes, but is usually overshadowed by other topics.

> "Well, to some extent, perhaps the most well-known terms and topics are resource optimization and the sharing economy, those are repeated every day." – Interviewee 9

Two of the interviewees, 1 and 2, said that the topic of sustainability has recently increased in the workplace.

> "Yeah, yes it has come out quite strongly recently, because in everything, it has to be taken into consideration. It has been quite closely involved in what has been developed here. We also have a project that focuses on sustainable tourism driven by another person. I think it is embedded into the language here. It has become an integral part of everything we are going to do here. You always have to think about it too, in everything you do, so it is visible." – Interviewee 1

> "Yes, we have been waking up to that more and more here. Clearly, even during the last six months, the environmental themes and challenges, such as sustainable tourism, have grown in our discussions, but of course… Tourism and sustainability is quite a challenging equation in many ways, so it is perhaps a bit like that… During the past six months we have woken up to it, that we also have to respond to the challenge. It is not an easy equation." – Interviewee 2

Interviewee 3 provided a good example of how the environment can come up in discussions in many different forms:

> "Yeah yes it comes up in different forms. Sustainable development and low carbon themes, as they are in the project's objectives, so they are always spoken about, with various words. But then there's been a lot of talk about carbon emissions and carbon offsets, and in general about emissions and climate effects, so yes, it is very much embedded into the used language." – Interviewee 3

The interviews revealed that environmental themes are very common in the interviewees' work discussions and that they are discussed often and with various terms. Some of the interviewees pointed out that the environmental topics have recently increased in their workplace. Only one interviewee answered that the environmental theme is not constantly present in the workplace discussions but is overshadowed by other topics.

6.3 Direct impacts of IT

The direct impacts of IT were studied by asking the interviewees how do green design, green manufacturing, green use and green disposal appear in their

smart tourism development projects. To achieve as comprehensive understanding as possible, some of the interviewees were also asked the following questions:

- In purchasing decisions, do you take into account the environmental friendliness of the producer? Is the use of IT energy efficient?
- Does your project strive to reuse or recycle technology? Is the disposal of technology handled with minimal environmental impact?

Most of the interviewees, 9 out of 10, said that in their project, green design, manufacturing, use and disposal have not been taken into account. The reasons for it varied: interviewee 4 said that they trust that the existing processes in the society take these things into account, and interviewees 5 and 7 said that these aspects have not been discussed because there are other things than IT that have greater environmental impacts.

> "Especially in my previous job, my tasks were more about the development of a software that had very little to do with any physical equipment, so there was very little interface with these subjects, these kinds of questions haven't come up before. Even now, we're mostly experimenting, so this hasn't come up. We are relying on the fact that society already has some processes in place for what is being done to an old device, and certain standards on how to act, so it has not in any way risen to a topic of discussion in my case." – Interviewee 4

> "In these solutions what we are currently rolling, I haven't considered it to be very problematic for IT, that there are other things where the environmental problems may be more visible." – Interviewee 5

> "Our application exists in the virtual world, so I don't feel that we have thought about this subject so actively or considered it to be very important. Maybe, I think that the energy consumption that goes into developing such an application is, however, small in relation and if compared to the environmental impact of, for example, private motoring." – Interviewee 7

Two of the interviewees, 9 and 7, answered that green design, manufacturing, use and disposal have not been taken into consideration, but when they were asked about their procurement decisions, some direct impacts could be found. Interviewee 9 suggested that sustainability might be a criterion for procurement in the future and interviewee 7 revealed that they have refurbished and reused information screens, but it emerged that it was due to synergistic interests and not for sustainability reasons.

> "We haven't acquired any new screens, these are existing screens of an existing advertiser, which have been modified on one side to touch screens. We are thinking about this from the benefit perspective. In any case, this advertiser would have installed these screens in the urban environment, so we have agreed that we can put these information screens in them. It broadens our information screen network in a way that reduces our need to acquire own equipment, or actually eliminates it alto-

> gether. That is to say, there is a desire to seek such synergies, and we don't have to invest in purchasing equipment." – Interviewee 7

> "We produce our own system, but if we make purchasing decisions from outside, we will try to favor local suppliers first and then the values of the company are considered. We try to support sustainable development and environmentally friendly activity, so they are one of the criteria." – Interviewee 9

Two of the interviewees, 6 and 9, said that that green design, manufacturing, use and disposal have not been taken much into consideration and that they concentrate more on the enabling impacts that IT and their solutions might have.

> "In my opinion, they haven't really been taken into consideration. The focus is more on, maybe we're thinking more about the actual service and its impact on the environment opposed to how it is produced and what is the impact from that." – Interviewee 6

> "With our service, we will exploit these already existing parking spaces, so for example, the city doesn't have to start building new ones and use their resources on such things. And then, in the future, these shared cars, they will result in less private motoring, so through those things, I think that these appear in our project." – Interviewee 9

Interviewee 1 introduced ways how direct impacts of IT are present in their project. Reusing and refurbishing are included in the green disposal of directs impacts of IT.

> "They appear in project in a way, since we are not developing equipment but applications and those information screens, which I've been working on recently. No new screens have been acquired, but we are utilizing existing ones. A few new Smart post parcel lockers have been acquired but these information screens come into existing advertising screens, transforming the current advertising surface into a touch surface on the other side. That is to say, in our project we don't acquire new equipment or products for these services, but we reuse these old ones." - Interviewee 1

The interviews revealed that in most of the interviewees' projects the direct impacts of IT have not been taken into consideration. Two of the interviewees stated that they refurbish and reuse old equipment, but one of them also stated that they reuse equipment because of synergistic interests and not for sustainability reasons. One also suggested that sustainability will be one of their procurement criteria in the future. The reasons for not taking the direct impacts into account varied. Some said that they are focusing on what their service can enable rather than what impacts the creation of the service causes. Some said that IT's direct impacts have not been considered because there are other things that cause greater negative environmental impacts, such as private motoring. One stated that they trust the existing processes of the society to tackle these issues. Altogether, it seems that the direct impacts of IT are not generally taken into account.

6.4 Enabling impacts of IT

The enabling impacts of IT were studied by asking the interviewees if their project focused on ICT systems and solutions that help reduce negative environmental impacts in different processes. Most of the interviewees answered that their project focuses on such solutions. The answers included many similar enabling impacts that the interviewees' projects generate. The enabling impacts found from the gathered interview data can be divided into the following categories: the decrease of physical materials, the decrease of private motoring, benefits to the environment through resource optimization, benefits to the environment through behavior change and benefits to the environment gained through raising the level of use of public transport services.

Half of the interviewees introduced operations that could influence human behavior. Although behavioral change is actually a systemic effect (addressed in chapter 6.5), achieved behavior change can bring forth many benefits for the environment. Directing people to change their behavior can lead to, for example, changed purchasing behavior, greener choices and reduced greenhouse gas emissions. The possible changes in behavior mentioned in the answers were choosing to walk instead of using a car or other vehicles, using public transport instead of private motoring, choosing greener food services and recycling.

> "But of course, there's that, we could guide people towards sustainable development and sustainable tourism in our application by adding, for example, an emission counter. If you walk a certain distance it would tell you how much you have saved emissions, so you wouldn't take a car and such. The application, of course, encourages walking, and this city center is quite compact. You can walk to many places and the app will tell you how much the distance is to your destination. For example, 300 meters, so it's really easy to get to many places. There are also routes, like tours, included in the application which are meant to be done by foot." – Interviewee 1

> "We've been thinking that could we direct the consumer behavior, for example, with an app that evaluates the carbon footprint of the journey. And combining it with some emission compensation model or some kind reward system and bring some sustainability solutions into it. And we've also been thinking about something about the food services in the area. Like rewarding for green choices, for example."- Interviewee 2

> "We're aiming for these enabling impacts, there has been talk (very extensively, not anything specific yet) on how to control people's behavior in the area, so that it would be easier to choose the local food, would be easier to use public transport and easier to make these choices beforehand. Perhaps we could add ready-made packages to the website, so that they would be designed so that the carbon footprint would be lower already." – Interviewee 5

Almost half of the interviewees said, that their solutions have resulted or could result in the decrease of physical materials, such as paper, plastic cards, entrance bracelets, building materials for new parking lots or cars.

> "Probably the application, since there are a lot of other services coming into it, for example, a digital library card. People no longer have to get the physical cards so much. And all the other electronic booking options and others, that reduce the amount of paper and other materials that the city services use, so though them there are these impacts." – Interviewee 1

> "Printing route schedules has also been stopped because they are now in the route guide app as digital. The self-driving busses are electric vehicles, so it directly reduces the use of fossil fuels," – Interviewee 4

> "We've been talking about, like when you're moving around in the area, so that yet again the customer's information and what services he's purchased could be in the customer's own phone, so that you wouldn't necessarily need a separate bracelet or such." – Interviewee 5

> "Well yes, we are developing solutions that, as I said earlier, enhance the use of resources, so that we wouldn't build too much of new things such as new parking lots or buy new cars, so in that way we're promoting environmental friendliness." – Interviewee 9

Most of the interviewees said, that their solutions have reduced or might reduce the amount of private motoring and unnecessary driving. The decrease in the amount of private motoring reduces the use of fossil fuels and emissions.

> "And if we're thinking about the moving or transportation, we can enable that when the traveler, who comes to the city, for example, with a private car, can get the information where to park already with the app, so that he doesn't have to drive around unnecessarily and try to look for a spot. " – Interviewee 3

> "As an example, the digital route guide reduces unnecessary driving, fuel, emissions." – Interviewee 4

> "We make it possible to find those parking spaces quickly and easily, so through that unnecessary driving is reduced, the drivers are using less gas when they avoid having to drive around and find a suitable place to park, and therefore the emissions are reduced. In addition, if the shared cars are introduced, there is no need to own a car. You don't always have to own everything, and you can use and utilize existing and already built and purchased things." – Interviewee 9

Some of the interviewees said that their solutions enable resource optimization. When resources are used efficiently, it allows to reduce unnecessary work, food waste and unnecessary construction. According to interviewee 7, gathering data from the travelers and habitants increases the possibilities of leading with knowledge and to optimize resources.

> "The food services are related to this, like what kind of food we are serving here in this area and how low-carbon it is, but on the other hand also, if many small operators come to the area, it would be wise for them to share freezer space or refrigerator space or other resources like that. It's an enabling impact in the sense that we can reduce waste and use the resources we have more efficiently." – Interviewee 3

> "I would say that we can gather data from users, through these apps, and it increases the possibilities of leading with knowledge and resource optimization. For example, if we think about the city's sport and recreational services, they can get information about the use of sports fields and other services, we can get information about the event goers, on how they transport themselves in the city, and then we can allocate the resources better. I think that is a pretty important enabling impact. But if we're thinking about a big event, the event goers are coming to the city, then the surrounding service providers can know from the data that where they are coming from, where they are going, and prepare for the spike in demand in their own services and supply. In that, the amount of waste is reduced, and we can prepare for the visitors at the right time." – Interviewee 7

More than half of the interviewees said that their solutions facilitate finding sustainable means of transport and possibly raise the level of public transport use.

> "And yes, the goal is to raise the level of public transport service use so that it competes better with private cars, so that we can reduce the number of private cars."- Interviewee 4

> "On the other hand, we are facilitating finding the options for sustainable transport, and in the future, with the tram, we will try to make sure that the whole travel chain is efficient, also for the user, in a way that it would be able to compete, both in terms of cost and time, compared to private car use, for example."- Interviewee 7

> "There are now various virtual guides and mobile applications which could include guides, and there are some Finnish firms who are offering these. There are more and more of these aimed for travelers in Finland. The traveler is able to get to know the city independently and use public transport for this, and on the other hand it saves money and local workforce, but maybe there is that you can get to know the city without taking a guided tour by using the public transport. These types of things are getting more common."- Interviewee 8

Only one of the interviewees, 10, said that their solutions do not aim for enabling impacts. When their service was discussed a bit deeper, it was revealed that their service had, however, some enabling impacts.

> "Well, we haven't really thought that we would try to make a bigger impact on the environment with our service, we've been focusing on making it easier for the tourist to find these attractions, because they are scattered around the province. But the application does include routes to the attractions, so it might reduce unnecessary driving. And in the future, we might add a list of services provided in the attraction, so the tourist knows whether or not to bring snacks or something like that, if the place has some food services. It might maybe reduce unnecessary buying of food?" – Interviewee 10

Based on the interviews, it can be said that the majority of the interviewees' projects are developing solutions that generate enabling impacts that help to reduce the burden on the environment. Five categories of enabling impacts were observed from the data: the decrease of physical materials, the decrease of private motoring, the benefits to the environment through resource optimization, the benefits to the environment through behavior change and the benefits to the environment gained through raising the level of use of public transport services. It was notable that many of these impacts could be observed from the same project, meaning that the solutions seem to help the environment in many ways simultaneously. Summary of the observations made from the research data are presented in Table 8.

Table 8. Observations from research data on IT's enabling impacts

Observation	**Number of observations (%)**	**Number of observations (no.)**
The decrease of physical materials	40%	4
The decrease of private motoring	70%	7
The benefits to the environment through resource optimization	30%	3
The benefits to the environment through behavior change	50%	5
The benefits to the environment gained through raising the level of use of public transport services	60%	6

6.5 Systemic impacts of IT

The systemic impacts of IT of the interviewees' projects were studied by asking them if they do any actions in their project that increase or create environmental awareness and if they believe that their ICT solutions will generate behavior or process change. More than half of the interviewees answered that their project has actions that increase or create environmental awareness, and also more than half said that their solutions generate behavior change. Half of the interviewees answered positively to both, meaning that their project increases environmental awareness and generates process change at the same time. These observations are summarized in Table 9. More than half said they have actions in their project that increase environmental awareness. From the research data, the found actions that increase or create environmental awareness were public reporting and marketing, through application content, collaborations with other businesses, organizations or groups, media, events and receiving visitor groups. The occurrences of these actions are summarized in Table 10.

Table 9. Observations from research data on IT's systemic impacts

Topic	Number of observations (%)	Number of observations (no.)
Increasing or creating environmental awareness	60%	6
Generating behavior or process change	60%	6
Increasing or creating environmental awareness & generating behavior or process change	50%	5

Interviewees 1, 4 and 8 said that they use public reporting or marketing as a mean to increase environmental awareness.

> "In addition, there's a tram worksite going on now, and when it's finished, it will certainly be reported and communicated, and we will encourage people to use public transport. They will be comprehensively reported then." – Interviewee 1

> "Those city bikes, there's a lot of public communication related to those. It's been a very visible service and surely it has affected people's attitudes also." – Interviewee 4

> "And we also do consumer marketing, and we want to bring forth communication related to these things. Finland is on a sustainable footing, and nature is the greatest value for us, and it also comes up on our communication. Now we have, for example, this Rent-a-Finn campaign, well of course, it's marketing communication, so we don't go very deeply into that theme, but it is very important for your whole country brand that sustainability and how people treat nature are in it." – Interviewee 8

Interviewees 1, 2 and 5 have thought about actions that increase environmental awareness through application content but have not yet implemented it. Interviewee 1 mentioned that they have talked about an emission calculator in the application that would report the saved emissions to the user. Interviewee 2 said, that they have thought about an application that calculates the journey's carbon footprint. Interviewee 5 said they have talked about sharing information about the traveler's surroundings during the journey done by foot or by bike through an application or service. All these actions indirectly increase the environmental awareness of the user.

> "We've been designing this thing, like if you are coming to the area on foot or by bike, that you could listen to some kind of, there could be multiple choices, some sort of route description that might give you information, nothing like ads or anything, but something about the area, something to make the trip more interesting. It would be more like "hidden" education, using these persuading techniques, not like brainwashing, but light shoving and encouraging toward the direction." – Interviewee 5

Interviewees 4, 6 and 8 said that they have had collaborations that increase environmental awareness.

> "We have done collaboration with different authorities, with Motiva and with different cycling organizations." – Interviewee 4

> "Well, I see it in a way that the communication raises these topics, and, for example, we have this developer club where we speak about these themes and what's going on, so there the environmental side is emphasized and visible. We have presented, for example, our carbon neutrality objectives and such." – Interviewee 6

> "Of course, also internationally, there's a lot of Nordic co-operation and we are discussing these things a lot with our Nordic colleagues, so I think there's a surface we can influence on." – Interviewee 8

Interviewee 6 also revealed many other actions they have taken to increase environmental awareness, such as media and international news, organizing events and receiving and educating international visitor groups.

> "We have these events and occasions which are directed to the habitants and they are invited to the experiment activities. You can see the motivation they have, they are interested in environmentally friendly solutions, like reducing food waste and such. Even though for the company, it's more for developing their product, but for the customers, they have the benefit of getting new information that interests them." – Interviewee 6

> "We receive these visitor groups, who are professionals, such as city delegations and ministerial delegations. They are often there for benchmarking, they are learning, so I think that's maybe the biggest impact, because it spreads the understanding of the solutions internationally. We have a lot of visitors from Asia and from Europe, some from African states, a little less from the US or Latin America." – Interviewee 6

> "Then there's a lot through media: this is a topic that really interests in the media, and our international media coverage is really wide. Our communications sector just presented those figures, and we're speaking about multimillion figures often per story, and there's a lot of these stories. We've had a project on CNN, Le Monde and the Guardian and papers such as them, and also on German news channels, documentaries and such. Those of course spread the awareness broadly, and then they will come to explore and hear more and pick something up for their own perspective and it conveys internationally." – Interviewee 6

Based on the interview responses, it can be said that just over a half of the respondents' projects are carrying out activities that increase environmental awareness. Public reporting, marketing, collaboration and application content were the most common means of increasing environmental awareness. One interviewee recounted multiple actions they do to have that effect, which included also media, events and receiving visitor groups. The different actions taken to increase the awareness are summarized in Table 10.

Table 10. Summary of occurrences of actions from the research data that increase environmental awareness

Actions of increasing environmental awareness found from the research data	**Number of observations (%)**	**Number of observations (no.)**
Public reporting & marketing	30%	3
Through application content	30%	3
Collaborations	30%	3
Media	10%	1
Events	10%	1
Visitor groups	10%	1

More than half of the interviewees said that in their projects, they have done or are planning to do actions that generate behavior change. The actions found in the research data are influencing behavior through an application or a website, public reporting and marketing, and one interviewee mentioned AR-content.

Four of the interviewees said that they are trying to influence behavior through an application or a website. Interviewee 1 said that their application encourages the user to choose walking instead of using other means of transportation. They have also thought about adding an emission counter to their application to guide people towards sustainability.

> ”But of course, there’s that, we could guide people towards sustainable development and sustainable tourism in our application by adding, for example, an emission counter. If you walk a certain distance it would tell you how much you have saved emissions, so you wouldn’t take a car and such. The application, of course, encourages walking, and this city center is quite compact. You can walk to many places and the app will tell you how much the distance is to your destination. For example, 300 meters, so it’s really easy to get to many places. There are also routes, like tours, included in the application which are meant to be done by foot.” – Interviewee 1

Interviewee 2 said that they have thought about directing consumer behavior with an application that evaluates carbon footprint and through rewarding for green choices in the application.

> “We’ve been thinking that could we direct the consumer behavior, for example, with an app that evaluates the carbon footprint of the journey. And combining it with some emission compensation model or some kind reward system and bring some sustainability solutions into it. And we’ve also been thinking about something about the food services in the area. Like rewarding for green choices, for example.”- Interviewee 2

Interviewee 5 mentioned product placement on their website as a possible means to direct people’s behavior towards sustainable choices.

> "We're aiming for these enabling impacts, there has been talk (very extensively, not anything specific yet) on how to control people's behavior in the area, so that it would be easier to choose the local food, would be easier to use public transport and easier to make these choices beforehand. Perhaps we could add ready-made packages to the website, so that they would be designed so that the carbon footprint would be lower already." – Interviewee 5

Two of the interviewees, 1 and 4, said that they believe that public reporting has modified people's behavior towards more sustainable solutions. Interviewee 1 said that their reporting on the completion of the tram might influence behavior, and that they will report it comprehensively and encourage the use of public transportation in their communication. Interviewee 4 said their communication concerning the city bikes has increased their usage and influenced behavior.

> "Those city bikes, there's a lot of public communication related to those. It's been a very visible service and surely it has changed people's behavior to some amount. If we're thinking about the kilometers that have been driven on the city bikes, well of course, it doesn't take it away from motor traffic everywhere, but certainly it has somehow contributed to it." – Interviewee 4

Interviewee 8 said that they have had a pilot project concerning AR content (Augmented Reality) that might cause behavior change by guiding the user on how to do things.

> "There's not a lot of this yet, but there are some pilot projects, some AR content is put on campfire sites in national parks, that guide you on how to start a fire, how you recycle and things like this. There's a lot of talk about these, but really these have been only in pilot project use." – Interviewee 8

The interviews revealed that more than half of these projects aim at behavioral change and most of them have taken actions to generate it. The actions included influencing behavior through an application or a website, public reporting and AR content. The actions of generating behavior change found in the research data are summarized in Table 11.

Table 11. Summary of the actions from the research data of generating behavior change

Actions of generating behavior change found from the research data	**Number of observations (%)**	**Number of observations (no.)**
Through application / website content	40%	4
Public reporting	20%	2
AR content	10%	1

6.6 Strategy and policy

This chapter presents the results for the theme strategy and policy. The theme has three main topics: objectives, strategy and policy. The results are presented in that order.

6.6.1 Objectives

The state of the sustainability objectives for ICT was studied by asking the interviewees if they have set objectives for sustainable development of ICT in their development project. All the interviewees answered that they have no set objectives for the sustainable development for ICT in their project. Three of the interviewees stated that setting objectives for these things has not occurred to them.

> "There are no objectives defined for that, it hasn't even crossed my mind before I became familiar with the term green IT." – Interviewee 8

> "No, we don't. We are so early in the development and it's just one application, so it hasn't even crossed my mind." – Interviewee 10

Interviewee 4 explained the lack of objectives by comparing their project's benefits to the possible impacts the development might cause.

> "No, I don't remember that in itself the ICT processes, devices or their environmental friendliness has been talked about. It is more like we are trying to make a bigger change through them, so it feels that it may be a small thing, or it feels like it's a little small compared to the advantages that we could gain from it, so we haven't taken that into consideration. If you need to buy some equipment so that people's behavior changes, then my assumption is that the proportion of the devices is small compared to the benefits from the behavior." – Interviewee 4

Interviewee 7 said that they do not have set such objectives in their project, but they are committed to the city's objectives and strategy, which include carbon neutrality objective.

The interviews reveal that there are no set objectives for sustainable development of ICT in these projects. The projects might follow someone else's strategy and objectives, the objectives of sustainable ICT are considered less important than the benefits gained through ICT or setting these objectives has not come to mind for some reason.

6.6.2 Strategy

The existence of sustainability strategies for ICT was studied by asking the interviewees if they have a strategy for sustainable development for ICT and if

they had, is it aligned with the business strategy. All ten interviewees stated that they do not have a strategy for sustainable development for ICT. Two of the interviewees said that they don't have any formed strategies (related to sustainability or otherwise) and three of the interviewees said that their project does not have a strategy for sustainable development of ICT, but they are following some other strategies by an governing entity, such as an university or a city or a bigger project.

> "Well, let's just say that this is a huge group of companies, when it comes to the whole university community. So, their strategy is our strategy, and I don't know much about that." – Interviewee 5

> "Well it's more through our commitment to this carbon neutrality action program and its implementation." – Interviewee 6

> "This project does not have a separate strategy. We are guided by the city strategy, so it's more or less integrated in all of the city's activities and into this project." – Interviewee 7

> "Well, we don't have any official strategy, so no, we don't." – Interviewee 9

Based on the interview responses, it was very clear that there are no separate strategies for sustainable development for ICT in these projects. The strategy is either non-existent or the projects might be committed to follow some other entity's strategy.

6.6.3 Policy

The existence of policies related to sustainability was studied by asking the interviewees if they had defined general policies regarding the sustainability of ICT solutions, such as a procurement policy, use policy and disposal policy. Six of the interviewees said that they do not have any policies. Interviewee 5 pointed out that having policies would be a good thing considering the project's goals.

> "If me move away from the university world and think about the whole project, I have to honestly admit that I think we have never discussed this, not once. But a good question, why not talk about it, because if we think about the project's goal, it could be good to include it in the project's internal control." – Interviewee 5

Interviewee 3 said that there are no policies but, in some sense, they function in a way that there might be.

> "Unfortunately, no, there are none relating to this. Well actually I think we don't even have slips on the walls that tell to minimize printing, for example. Remote meetings are favored, reducing travel is perhaps a specific goal, but saving time and money is more likely to be the reason than sustainability." – Interviewee 3

Three of the interviewees said that they did not know, if they had policies in their project. Interviewee 8 said that he/she was not aware if there were any policies but pointed out that their office is paperless, and they do not have fixed working spaces, so there might be some policies in the background.

> "This I don't actually know, but in practice… our IT department handles stuff like that, so individual people don't know, I guess there's a process, but it's not well-communicated." – Interviewee 8

> "Yeah, actually it came to mind that we have a paperless office, that there's no paper anywhere and no one has their own working station, and you can't even see dumpsters pretty much anywhere, so it's basically totally paperless, maybe sometimes a single contract has to be printed but nothing else. And on the other hand, if you think about our spaces, we don't have working stations for everyone, because the thought is that you can also work remotely, so we're saving by it because there's not a workstation for every 600 employees, but I don't know how many, probably something 20% less." – Interviewee 8

Only one of the interviewees, 4, said that there are some policies regarding the use of ICT and electricity.

> "There were some instructions for the use of electricity, like turn of the lights when you leave the room and set your computer on power-saving mode when you are not using it, or something like that. They are so common, like civic competence, so I don't know how official they were." – Interviewee 4

The interviews revealed that policies regarding the sustainability of ICT solutions have not generally been defined for these projects. Only one of the interviewees said that they had some policies regarding electricity and computer use. Most of the interviewees said that they had no policies and three of them did not know. Summary of the existence of policies regarding sustainability of ICT in these projects is presented in Table 12.

Table 12. Summary of the existence of policies found in the research data

The existence of policies	**Number of observations (%)**	**Number of observations (no.)**
Some policies	10%	1
No policies	60%	6
No knowledge about policies	30%	3

6.7 Governance

This chapter presents the results for the theme governance. The theme has two main topics: standards and metrics, and roles, responsibilities, accountabilities and control. The results are presented in that order.

6.7.1 Standards and metrics

The existence of standards and metrics for monitoring sustainable development of ICT was studied by asking the interviewees if they had any such standards or metrics. Three of the interviewees said they did not know if there were any standards and metrics for monitoring the sustainable development of ICT.

> "No, not to my knowledge." – Interviewee 1

Most of the interviewees, 7 out of 10, stated that they do not have any standards or metrics that are used for monitoring sustainability of their ICT solutions.

> "No, not in my opinion, all the goals are related to the project's actual topic, not to how we act and work. So, I'm assuming that our project is relatively small, if you think about the funding, so there are no ridiculous travel expenses or anything similar and the expenses of the digital side do not accumulate for us. So, I think that because of that, this has been left as a dark spot, because everyone works really with the tools they have anyway. So, it would be more like thinking about the general ways of doing things which are not any way specific for this project." – Interviewee 5

Interviewees 9 and 10 said that there are no standards or metrics for sustainability but rather for following the number of users.

> "No, at least not on the environmental level. The number of users will be monitored at least in the beginning" – Interviewee 9

> "No, we haven't defined those when we don't have the actual sustainability strategy. We're more interested in the users and how many of them we have in this initial phase." – Interviewee 10

According to the interviews, standards and metrics for monitoring sustainable development of ICT have not been defined in these projects. Most of the interviewees said that there are no standards or metrics, and the last three interviewees did not know if there were any.

6.7.2 Roles, responsibilities, accountabilities and control

To investigate roles, responsibilities, accountabilities and control, the interviewees were asked if they had defined roles and responsibilities for monitoring and

implementing sustainable development. Most of the interviewees, 7 out of 10, stated that they do not have defined roles and responsibilities for monitoring sustainable development.

> "No, we haven't, we have only defined that we will advance sustainable mobility in the goals of the project, but nothing more specific, so there's no person accountable for these things." – Interviewee 7

> "There's no defined person responsible for these." – Interviewee 9

One of the interviewees, 3, did not know if there was a person defined for these roles.

> "I have to say I don't know." – Interviewee 3

Two of the interviewees, 4 and 8, said that there are some people in charge of some of these, but it was left unclear whether their responsibilities included specifically monitoring and implementing sustainable development.

> "We have a person responsible for ICT and technical matters and procurement, like in the corporate level. But of course, there are some smaller purchases done inside the projects." – Interviewee 4

> "From the perspective of the development of the tourism industry, we have a person defined for that role, but at the whole business level, I don't know." – Interviewee 8

Based on the acquired answers to the question, it can be said that most of the interviewees' projects do not have defined roles and responsibilities concerning monitoring and implementing sustainable development.

6.8 Summary of the results

All the results of the study are summarized in Table 13. The table presents the themes and their topics, and the questions related to the topics. The results of each topic are summarized in the last column.

Table 13. The summarized results of the study by theme and topic.

Theme	Topic	Question	Result
Attitude, people & culture	Subjective motivation	Does the state of the environment, different environmental impacts and climate change worry you personally?	All 10 interviewees worry about environmental issues to some extent.
		Do you consider it important to consider environmental impacts when designing ICT solutions for smart tourism development?	9/10 interviewees regard environmental factors to be important when designing ICT solutions.
	Subjective capabilities	Do you believe that you can influence the state of the environment through your actions in your job? How?	9/10 interviewees feel that they can influence the state of the environment to some extent.
	Language	Does your working environment have communication and vocabulary related to sustainable development?	9/10 interviewees feel that sustainability is a common topic in their workplace conversations.
Direct impacts of IT	Green design, manufacturing, use and disposal	How do green design, manufacturing, use and disposal appear in your project?	9/10 interviewees said that in their project, green design, manufacturing, use and disposal have not been taken into account.
		In purchasing decisions, do you take into account the environmental friendliness of the producer? Is the use of IT energy efficient?	
		Does your project strive to reuse or recycle technology? Is the disposal of technology handled with minimal environmental impact?	
Enabling impacts of IT	The use of IT to support, assist and leverage other environmental initiatives	Does your project focus on ICT systems and solutions that help reduce negative environmental impacts in different business processes?	9/10 projects focus on solutions that generate enabling impacts of IT.

(continues)

Table 13 (continues)

Systemic impacts of IT	Creating green awareness and promoting green agenda	Do you do any actions in your development project that increases or creates environmental awareness? How?	6/10 projects have actions that increase environmental awareness.
	Behavioral change & process change	Do you believe that the ICT solutions used in your development project will generate behavior or process change? How?	6/10 interviewees believe that their project generates behavior change.
Strategy & policy	Objectives	Have you set objectives for sustainable development of ICT in your development project?	All 10 projects do not have objectives for sustainable development of ICT.
	Strategy & alignment	Do you have a strategy for sustainable development for ICT? If you do, has it been aligned with the business strategy?	All 10 projects have not defined a strategy for sustainable development for ICT.
	Policy	In your development project, have you defined general policies regarding the sustainability of ICT solutions, such as procurement policy, use policy, disposal policy etc.	9/10 projects do not have general policies regarding the sustainability of ICT solutions.
Governance	Standards & metrics	Do you have any standards or metrics to help you monitor the sustainability of your ICT solutions?	7/10 projects do not have standards or metrics for monitoring the sustainability of ICT solution. 3/10 interviewees did not know.
	Roles, responsibilities, accountabilities and control	Have you defined roles and responsibilities of monitoring and implementing sustainable development?	7/10 projects do not have a person responsible for monitoring and implementing sustainable development. 1 interviewee did not know. 2 interviewees mentioned some roles, but the definite response was unclear.

7 DISCUSSION

This chapter reviews and discusses the results of the study and considers the relevance of the research results. Then, the reliability and validity of the study are examined, and generalization of the results is contemplated. The limitations of the study are also assessed.

7.1 Green IT perspective on Finnish smart tourism development

Tourism is a conflicting topic as it is the main source of income for many areas, cities and countries, but at the same time it generates a very large amount of negative environmental impacts. For example, it has been estimated that the tourism industry accounts for 5.2-12.5% of world's global warming potential. The objective of this study was to assess the state of sustainability of Finnish smart tourism development by examining how green IT principles are incorporated in Finnish smart tourism development. Based on the research problem, the following research question was defined for the empirical study:

- How are green IT sustainability principles incorporated in Finnish smart tourism development and its ICT solutions?

The empirical study was conducted by using a research framework based on the literature review that consisted of six themes: attitude, people and culture, direct impacts of IT, enabling impacts of IT, systemic impacts of IT, strategy and policy and governance. The study reveals that interviewees are worried about the state of the environment and consider it to be important to take environmental issues into account when designing ICT solutions to support tourism. Environmental topics are also a common theme in their discussions at work. Most of the interviewees feel that their actions have some impact on the state of the environment, but also feel that their capabilities to influence are somehow limited. In most of the studied projects, the direct impacts of IT have not been taken into account. The reasons for this were, for example, focusing on the ena-

bling effects, small scale of the project, or the fact that there are other things that have a bigger negative impact on the environment than their project. However, most of the projects focus on generating enabling impacts of IT. The found enabling impacts can be divided into the following categories: decrease of physical materials, decrease of private motoring and benefits to the environment through resource optimization, behavior change and raising the level of use of public transport services. When examining the systemic impacts of IT, it was found that just over half of the projects execute actions that increase environmental awareness and just over half of the projects' ICT solutions generate behavior change toward sustainable choices. The found actions that increase or create environmental awareness were public reporting and marketing, through application content, collaborations with other businesses, organizations or groups, media, events and receiving visitor groups. In terms of strategies and policies, it was revealed that most of the projects do not have objectives or a strategy for sustainable development of ICT. Also, most of the projects have not defined policies regarding ICT use, procurement or disposal. The same was found to be true for governance: most of the projects were found not to have standards and metrics for monitoring the sustainability of ICT solutions or a person responsible for monitoring and implementing sustainable development.

Green IT principles appear in Finnish smart tourism development mostly through attitudes, enabling impacts and systemic impacts. In all projects, environmental issues were regarded as an important part of the development of smart tourism, and many enabling and systemic impacts were found in the study. Taking the direct impacts of IT into account was found to be at a weak state. At the strategic and governing level, environmental factors were found to be poorly regarded. Environmental factors are not included in strategies, policies and responsibilities regarding the development or use of ICT.

The purpose of the study was to investigate and describe the state of smart tourism development in Finland. The results of the study can hardly be compared to previous results, since the sustainability of smart tourism development has not been studied before from this perspective, or at least no published research can be found on the subject. Based on the results, it can be stated that the research framework is suitable for studying the research question, as it served its purpose and provided new comprehensive and rich information on Finnish smart tourism development from the set themes and topics.

It can be said that the results of the study were not surprising, at least for some of the themes. Around the world, concerns about the state of the environment have intensified over the last decade and environmental awareness has increased. Therefore, one could have assumed that the interviewees might share this worry for the environment, as they do based on the results. As personal attitudes are a driving force in taking action to tackle environmental concerns, the development of smart tourism in Finland seems to be on a good and solid foundation, if measured by attitudes. It is noteworthy that the direct impacts of IT were hardly taken into consideration and that many of the interviewees said that they have not even thought about technology from that per-

spective. Some of them agreed that it should play a bigger part in the development in the future.

The literature review answered two of the supporting research questions: *"What is smart tourism and smart tourism development?"* and *"Which technologies and ICT solutions are used in smart tourism development?".* The definition of smart tourism guided the selection of interviewees, and projects were found that met the criteria of smart tourism. The smart tourism ICT solutions presented in this study increase the number of reported ICT solutions for smart tourism. Another supporting question was defined for the literature review: *"What are green IT and green IT sustainability principles?".* By answering this question, the key principles of green IT were found and used to create the research framework. The study brings new knowledge to both disciplines, especially for the field of smart tourism.

The fields of green IT and smart tourism seem to be quite unknown in the Finnish tourism field since most interviewees had not heard from neither of them, even though they are all working on projects that can be defined as smart tourism development. Most of the research literature on green IT and smart tourism is from the 21st century and therefore, they are relatively new research topics. Hence, it is understandable that the knowledge on these topics has not spread deep into the field of tourism.

Since this topic has not been studied in Finland before, this research produces new information and possible benefits for the Finnish tourism industry. The research results address the current state of sustainability of Finnish smart tourism development and the research framework provides a basis for improving the sustainability of smart tourism development, as the themes and their purpose can be considered as building blocks of sustainability. Since many of the interviewees had not heard about these topics before, it can be said that the study provides new information for the tourism industry. Some interviewees said that participating in the study was a good thing since it offered them a new perspective on what to pay attention to if they want to develop smart tourism in a sustainable manner. The study also presents and describes smart tourism ICT solutions that have either been completed or planned, which may inspire the development of smart tourism more widely. The results of the study and the research framework can be used in the future in planning and managing smart tourism projects towards more sustainable development. But since the framework is not very detailed and focuses on broad themes, further research is needed to provide instructions and directions for sustainable smart tourism development.

7.2 Validity, reliability, generalization and limitations of the study

This chapter assesses the reliability and validity of the study, its potential for generalization and possible limitations of the study. Some constraints and limitations were identified related to previous studies, the used research methods and the interviewees.

On the basis of the research completed for the literature review, it can be said that no published research on the same subject has been made in the past. There exists a great deal of literature, articles and research on green IT. Literature on smart tourism is not as plentiful: most of the smart tourism literature consists of research articles published in the last decade since it is a relatively new subject. No previous research was found that specifically explored smart tourism from a green IT perspective or directly studied the sustainability of smart tourism development or smart tourism solutions. However, the literature review provided comprehensive information on both topics. A chapter that presents research that combines the topics, green IT and smart tourism, could not be added into the literature review due to the lack of earlier studies on the subject. The earlier research and literature on the two subjects were systematically collected using certain key words and various databases, which increases the reliability of the study.

Different models and frameworks of green IT literature were combined to provide a comprehensive framework for studying the state of sustainability of projects that develop smart tourism solutions. The validity of the study is increased by using a framework that is suitable to study the topic. The research framework was created to be used in the empirical research to explore how the green IT principles are incorporated in Finnish smart tourism development. The interview questions were formed on the basis of the created research framework. As the interview phase progressed and more interviews had been conducted, the framework was found to be suitable to explore the subject since the interviews provided information on all the initial themes and topics. The data gathered were very rich in information in some of the themes. Thus, it can be assumed that the research framework is suitable for studying the research question, which increases the validity and reliability of the study.

The interviewees were selected by discretionary sampling which is common in qualitative research (Hirsjärvi et al., 2016, p. 164; Hirsjärvi & Hurme, 2015, p. 59). The interviewees worked in various different projects and they also held different positions in the projects. The aim of the sampling was to obtain as comprehensive depiction of the research subject as possible, which increases the reliability and validity of the study and the possibility of generalization. However, the possibility of generalization of the results might be reduced by the small sample size. The objective was to obtain at least 12 interviewees as in qualitative research, the appropriate amount is always determined by the purpose of the study (Hirsjärvi & Hurme, 2015, p. 58). In this study, 10 people

agreed to an interview. Nevertheless, it was found to be an appropriate amount since the interviews generated new information from each theme and topic. New information was obtained from the research data which shows that the small sample size did not significantly limit the purpose of the study or its reliability. However, the interviews were obtained only from three Finnish cities, which might constrain the generalization of results.

The interviews were conducted as semi-structured interviews, since openness, flexibility and improvisation are required for qualitative interviews. The objective was to get as diverse information as possible about the research topics and semi-structured interview method provided the best opportunity to gather such information. Choosing a semi-structured interview method as the data gathering method increases the reliability and validity of the study. It is also favorable to use a framework as the basis of the interview structure because it aids the interviewer to lead the interview meaningfully towards the research topics. Using a framework in the interviews helps to obtain detailed and rich information, which increases the validity of the study.

Using interviews as the data collection method can in some cases be a threat to the reliability and validity of a study, since interviews have some weaknesses. Conducting interviews requires the researcher to be trained in creating a valid interview frame and conducting an interview. Poorly conducted interview can lead to distorted answers. The interviewee's answers may also be distorted for other reasons. The interviewee may experience the interview setting to be threatening which may affect his/her answers. People also have a higher tendency to give socially acceptable answers in interviews. In this study, the focus was on sustainability, and it is possible that some of the interviewees might have colored their responses to create a more sustainable and responsible image for their project. However, most of the interviewees admitted straightforwardly, for example, that they do not have a sustainability strategy. Therefore, the answers seem honest and undistorted. Sometimes, the interviewee might misunderstand the question, which causes invalid answers. The probability of this happening was reduced during the interviews by explaining the questions carefully and rephrasing the question if the interviewee seemed to understand it incorrectly. The interviewees might also distort their answers because they might not want to talk about their employer in an unfavorable manner. The impact of this was reduced by promising full anonymity. The impact of other people was also removed from the interview setting by conducting the interviews as individual interviews where no other people could influence the answers.

It is often difficult to assess the reliability of a study when the research is done using qualitative methods. Accurate and truthful descriptions of people, methods and cases are central in assessing reliability in qualitative research. The reliability is increased by describing the implementation of the research as accurately as possible. (Hirsjärvi & Hurme, 2015, p. 232.) The implementation of the empirical research is described in detail in the previous chapters, and therefore, it can be said that the accurate description increases the reliability of the study.

8 CONCLUSION

This chapter presents a summary of the study, conclusions and further research topics. First, a summary of the content and the course of the study will be presented. Next, the conclusions of the study are depicted, and the significance of the study is assessed from both academic and practical perspective. Finally, the chapter presents possible further research topics.

The purpose of this master's thesis was to examine the state of sustainability of Finnish smart tourism development by investigating how green IT principles are incorporated in Finnish smart tourism development. Smart tourism is a new form of tourism in which the tourism services are supported by various ICT solutions. However, tourism is a contradictory topic as it is a very important source of income for many countries, but at the same time it produces a very large number of negative environmental impacts which is why it is important to develop smart tourism in a sustainable manner. Since the development of smart tourism is heavily focused on ICT solutions, it is justified and important to study smart tourism on the basis of green IT.

The study consisted of a literature review and qualitative empirical research. The literature review of the study is presented in chapters 2-4. The literature review defined the relevant concepts of the study and discussed previous studies on the fields of green IT and smart tourism. On the basis of the literature review, a theoretical framework was created and used in the empirical research. The chosen empirical research methods were presented in chapter 5, including a description of the data collection method and analysis methods. The data was collected using qualitative semi-structured interviews that were transcribed into written form. The transcribing was followed by an analysis that consisted of reading, categorization, finding connections and reporting. The research results were presented in chapter 6 grouped according to the themes of the theoretical framework, which were attitude, people and culture, direct impacts of IT, enabling impacts of IT, systemic impacts of IT, strategy and policy and governance. Chapter 7 presented the discussion of the research results which answered the research question, considered the relevance of the study and evaluated the reliability, validity, generalization and limitations of the study.

The objective of this study was to assess the level of sustainability of Finnish smart tourism development. The following research question was formed based on the research problem:

- How are green IT sustainability principles incorporated in Finnish smart tourism development and its ICT solutions?

In order to gain a deeper understanding of the research topic, the following supporting questions were defined for the study:

- What is smart tourism and smart tourism development?
- Which technologies and ICT solutions are used in smart tourism development?
- What are green IT sustainability principles?

Answers to the supporting research questions were sought in the literature review. Smart tourism was defined as all touristic activities that are informed, supported and completed by smart technology. Smart technology is used to create, manage and to deliver intelligent touristic services through information sharing and value co-creation. Smart tourism development can be divided into developing ICT solutions for smart tourism or developing the smart tourism destination. The technologies used in smart tourism are based on the same technologies used in smart cities, the most notable ones being IoT (Internet of Things), cloud computing and End-User Internet service systems. Green IT sustainability principles were defined as the means to decrease the harmful effects on the environment by sustainable ICT, IT applications and practices. Green IT principles, practices, approaches and frameworks were presented in chapter 3.

The main goal of the study was to answer the research question through the literature review and empirical research. According to the results, green IT principles are incorporated in Finnish smart tourism development mostly through attitudes, enabling impacts and systemic impacts. In all studied projects, environmental issues were considered to be an important part of the development of smart tourism. It was evident that different negative environmental impacts worry the interviewees personally. Most of the interviewees feel that their actions have some impact on the state of the environment, but also feel that their capabilities to influence are somehow limited. Environmental topics are also a common discussion topic in their working environments. Most of the projects focus on generating enabling impacts IT and systemic impacts of IT, and many enabling and systemic impacts were found in the study. The found enabling impacts can be divided into the following categories: decrease of physical materials, decrease of private motoring and benefits to the environment through resource optimization, behavior change and raising the level of use of public transport services. When examining the systemic impacts of IT, it was found that just over half of the projects execute actions that increase environmental awareness and just over half of the projects' ICT solutions generate be-

havior change toward sustainable choices. The found actions that increase or create environmental awareness were public reporting and marketing, through application content, collaborations with other businesses, organizations or groups, media, events and receiving visitor groups. Taking the direct impacts of IT into account was found to be at a weak state. At the strategic and governing level, environmental factors were found to be taken poorly into account. Environmental factors were found not to be included in strategies, policies and responsibilities regarding the development or use of ICT.

This research produced new comprehensive information and possible benefits for the Finnish tourism industry. The research results address the current state of sustainability of Finnish smart tourism development. The framework used provides a possible tool for improving the sustainability of smart tourism development, as the themes and their topics can be regarded as building blocks of sustainability for ICT. Since this topic has not been studied before from this perspective, the information produced by this study provides an opportunity for further research.

Although the research framework was created to study the sustainability of smart tourism development, it can be used to examine the sustainability of other endeavors, as ICT plays a large role in most organizations. During the interviews, it emerged that the field of Finnish smart tourism development is fragmented: there are a lot of individual small actors conducting similar things, but there seems to be little cooperation between them. The projects are also often governed by a city or other larger entity, and therefore, the projects themselves are not independent and cannot make their own strategies and objectives. Several interviewees also highlighted the conflict between tourism and sustainability. However, it is unlikely that the amount of traveling and tourism in the world would be decreasing and the contradiction between tourism and sustainability will continue to be a concern, which is why the issue should be explored thoroughly.

As the Finnish field of smart tourism development is fragmented, it would be interesting to explore the links between projects and get a clear view on who is eventually in charge of these individual projects. Since the purpose of this research was to establish an overview of the sustainability of Finnish smart tourism development projects, information was wanted from each of the six themes. The interviews were limited to a few questions per theme because of time and resource constraints. In order to study this subject further and to attain a more detailed description of the state of sustainability of individual smart tourism development projects, the reference framework and the interview frame could be refined, and several interviews could be conducted per project. This would provide a more accurate and realistic depiction of the project's level of sustainability. It would also be interesting to study the level of sustainability of Finnish smart tourism development with a larger and demographically broader sample. This would be useful for a better generalization of the research results.

REFERENCES

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology*, *22*(1), 1–19. https://doi.org/10.1080/10630732.2014.942092

Archer, B., Cooper, C., & Ruhanen, L. (2005). The positive and negative impacts of tourism. In W. F. Theobald (Ed.), *Global tourism* (Third edit, pp. 79–102). https://doi.org/10.1016/S0304-8853(02)00611-X

Boes, K., Buhalis, D., & Inversini, A. (2015). Conceptualising Smart Tourism Destination Dimensions. In *Information and Communication Technologies in Tourism 2015* (pp. 391–403). https://doi.org/10.1007/978-3-319-14343-9_29

Boes, K., Buhalis, D., & Inversini, A. (2016). Smart tourism destinations: ecosystems for tourism destination competitiveness. *International Journal of Tourism Cities*, *2*(2), 108–124. https://doi.org/10.1108/IJTC-12-2015-0032

Buhalis, D., & Amaranggana, A. (2013). Smart Tourism Destinations. In *Information and Communication Technologies in Tourism 2014* (pp. 553–564). https://doi.org/10.1007/978-3-319-03973-2_40

Buhalis, D., & Amaranggana, A. (2015). Smart Tourism Destinations Enhancing Tourism Experience Through Personalisation of Services. In *Information and Communication Technologies in Tourism 2015* (pp. 377–389). https://doi.org/10.1007/978-3-319-14343-9_28

Cacho, A., Estaregue, D., Figueredo, M., Lucas, J., Aurelio, M., Farias, H., … Alves, C. (2015). A smart destination initiative: The case of a 2014 FIFA world cup host city. *2015 IEEE 1st International Smart Cities Conference, ISC2 2015*. https://doi.org/10.1109/ISC2.2015.7366223

Caragliu, A., del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82. https://doi.org/10.1080/10630732.2011.601117

Casagrandi, R., & Rinaldi, S. (2002). A theoretical approach to tourism sustainability. *Ecology and Society*, *6*(1), 13. https://doi.org/10.5751/ES-00384-060113

Chiappa, G. Del, & Baggio, R. (2015). Knowledge transfer in smart tourism destinations: Analyzing the effects of a network structure. *Journal of Destination Marketing & Management*, *4*, 145–150. https://doi.org/10.1016/j.jdmm.2015.02.001

Dao, V., Langella, I., & Carbo, J. (2011). From green to sustainability: Information Technology and an integrated sustainability framework. *Journal of Strategic Information Systems*, *20*(1), 63–79. https://doi.org/10.1016/j.jsis.2011.01.002

Donnellan, B., Sheridan, C., & Curry, E. (2011). A Capability Maturity Framework for Sustainable Information and Communication Technology. *IEEE Computer Society*, *13*(1), 33–40. https://doi.org/1520-9202/11/

European Environment Agency (2015). Tourism. Accessed online (January 21st,

2019) at https://www.eea.europa.eu/soer-2015/europe/tourism/

Gholami, R., Shirazi, F., Ravishankar, M. N., & Machet, C. (2017). An exploratory study on sustainable ICT capability in the travel and tourism industry: The case of a global distribution system provider. *Communications of the Association for Information Systems*, *40*(1), 479–501. https://doi.org/10.17705/1CAIS.04022

Good News from Finland (2018). Helsinki is an EU Capital of Smart Tourism. Accessed online (September 25, 2018) at http://www.goodnewsfinland.com/helsinki-is-a-eu-capital-of-smart-tourism/

Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: foundations and developments. *Electronic Markets*, *25*(3), 179–188. https://doi.org/10.1007/s12525-015-0196-8

Gretzel, U., Werthner, H., Koo, C., & Lamsfus, C. (2015). Conceptual foundations for understanding smart tourism ecosystems. *Computers in Human Behavior*, *50*, 558–563. https://doi.org/10.1016/j.chb.2015.03.043

Gretzel, U., Zhong, L., & Koo, C. (2016). Application of smart tourism to cities. *International Journal of Tourism Cities*, *2*(2), IJTC-04-2016-0007. https://doi.org/10.1108/IJTC-04-2016-0007

Harrill, R. (2004). *Residents ' Attitudes toward Tourism Development : A Literature Review with Implications for*. *Journal of Planning Literature*. Retrieved from http://journals.sagepub.com/doi/pdf/10.1177/0885412203260306

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for Smarter Cities. *IBM Journal of Research and Development*, *54*(4), 1–16. https://doi.org/10.1147/JRD.2010.2048257

Helsinki (2018). Open data and innovation. Accessed online (January 31st, 2019) at https://www.myhelsinki.fi/en/helsinki2018-meeting/open-data-and-innovation

Helsinki (2018b). Environmental sustainability. Accessed online (January 31st, 2019) at https://www.myhelsinki.fi/en/helsinki2018-meeting/environmental-sustainability

Hirsjärvi, S. & Hurme, H. (2015). Tutkimushaastattelu: Teemahaastattelun teoria ja käytäntö. Helsinki: Gaudeamus Helsinki University Press.

Hirsjärvi, S., Remes, P. & Sajavaara, P. (2016). Tutki ja kirjoita (21. uud. painos). Helsinki: Tammi.

Jenkin, T. A., Webster, J., & McShane, L. (2011). An agenda for "Green" information technology and systems research. *Information and Organization*, *21*(1), 17–40. https://doi.org/10.1016/j.infoandorg.2010.09.003

King, B. E. M., Pizam, A., & Milman, A. (1993). Social impacts of tourism. *Annals of Tourism Research*, *20*(4), 650–665. https://doi.org/10.1016/0160-7383(93)90089-L

Koo, C., Gretzel, U., Hunter, W. C., & Chung, N. (2015). Editorial : The Role of IT in Tourism. *Asia Pacific Journal of Information Systems*, *25*(1), 99–104. https://doi.org/10.14329/apjis.2015.25.1.099

Li, Y., Hu, C., Huang, C., & Duan, L. (2017a). The concept of smart tourism in the context of tourism information services. *Tourism Management*, *58*, 293–300. https://doi.org/10.1016/j.tourman.2016.03.014

Li, Y., Hu, C., Huang, C., & Duan, L. (2017b). The concept of smart tourism in the context of tourism information services. *Tourism Management*, *58*, 293–300. https://doi.org/10.1016/j.tourman.2016.03.014

Maliene, V., Grigonis, V., Palevičius, V., & Griffiths, S. (2011). Geographic information system: Old principles with new capabilities. *URBAN DESIGN International*. https://doi.org/10.1057/udi.2010.25

May, V. (1991). Tourism, environment and development. *Tourism Management*, *12*(2), 112–118. Retrieved from https://ac.els-cdn.com/0261517791900652/1-s2.0-0261517791900652-main.pdf?_tid=a138beae-e5e4-4527-ba53-11845e741aa4&acdnat=1542563038_5bfe49fc4054e0feaaf61e754572cdcb

Mckercher, B. (1993). Some Fundamental Truths About Tourism: Understanding Tourism's Social and Environmental Impacts. *Journal of Sustainable Tourism*, *1*(1), 6–16. Retrieved from https://www.researchgate.net/profile/Bob_Mckercher/publication/249023827_Some_Fundamental_Truths_About_Tourism_Understanding_Tourism%27s_Social_and_Environmental_Impacts/links/58021df808ae310e0d9db3a0.pdf

Mingay, S. (Gartner). (2007). *Greent IT: The New Industry Shock Wave*. Retrieved from http://mediaproducts.gartner.com/reprints/microsoft/153703.html[9/10/200810:59:08AM]

Mishra, D., Akman, I., & Mishra, A. (2014). Theory of Reasoned Action application for Green Information Technology acceptance. *Computers in Human Behavior*, *36*, 29–40. https://doi.org/10.1016/j.chb.2014.03.030

Molla, A., Cooper, V., Corbitt, B., Deng, H., Peszynski, K., Pittayachawan, S., & Teoh, S. Y. (2008). E-readiness to G-readiness: Developing a Green Information Technology readiness framework. In *Proceedings of 19th Australasian Conference on Information Systems* (pp. 669–678). https://doi.org/10.13140/2.1.1440.5922

Murugesan, S. (2008). Harnessing Green IT : Principles and Practices - Adopting a Holistic Approach to Greening IT is our Responsibility toward Creating a More Sustaining Environment. *Green Computing*, (February), 24–33. https://doi.org/10.1002/9781118305393

Murugesan, S., & Gangadharan, G. R. (Eds.). (2012). Harnessing green it : Principles and practices. John Wiley & Sons, Incorporated, New York. Retrieved from https://ebookcentral.proquest.com

Myers, M. D., & Newman, M. (2007). The qualitative interview in IS research: Examining the craft. *Information and Organization*, *17*(1), 2–26. https://doi.org/10.1016/j.infoandorg.2006.11.001

Oxford Living Dictionaries (2019). Definition of sustainability. Accessed online (January 14, 2019) at

https://en.oxforddictionaries.com/definition/sustainability

Pan, S. Y., Gao, M., Kim, H., Shah, K. J., Pei, S. L., & Chiang, P. C. (2018). Advances and challenges in sustainable tourism toward a green economy. *Science of the Total Environment*, *635*, 452–469. https://doi.org/10.1016/j.scitotenv.2018.04.134

Put-Van Den Beemt, W., & Smith, R. (n.d.). *SMART TOURISM TOOLS: LINKING TECHNOLOGY TO THE TOURISTIC RESOURCES OF A CITY*. Retrieved from https://www.cett.es/fitxers/campushtml/MiniWebs/122/papers/PUT_SMITH.pdf

Schultze, U., & Avital, M. (2011). Designing interviews to generate rich data for information systems research. *Information and Organization*, *21*(1), 1–16. https://doi.org/10.1016/j.infoandorg.2010.11.001

Su, K., Li, J., Fu, H., Nam, T., Pardo, T. A., Bakici, T., … Vanolo, A. (2015). Smart City and the Applications. *UOC Papers: Revista Sobre La Sociedad Del Conocimiento*, *76*(2), 11. https://doi.org/10.1016/j.future.2016.12.035

Tuomi, J. & Sarajärvi, A. (2018). Laadullinen tutkimus ja sisällönanalyysi, uudistettu laitos. Helsinki: Kustannusosakeyhtiö Tammi.

UNWTO (2019). Understanding Tourism: Basic Glossary. Accessed online (January 14, 2019) at http://statistics.unwto.org/sites/all/files/docpdf/glossaryterms.pdf

UNWTO (2019b). Why Tourism? Accessed online (January 21st, 2019) at http://www2.unwto.org/content/why-tourism

Wang, D., Li, X., & Li, Y. (2013). China's "smart tourism destination" initiative: A taste of the service-dominant logic. *Journal of Destination Marketing and Management*, *2*(2), 59–61. https://doi.org/10.1016/j.jdmm.2013.05.004

APPENDIX 1 THE SEMI-STRUCTURED INTERVIEW FRAME (PUOLISTRUKTUROITU HAASTATTELURUNKO)

Haastateltavien taustatiedot:

1. Mikä on työtehtäväsi?
2. Kuvailisitko, mitä työnkuvaasi kuuluu?

Asenne, ihmiset ja kulttuuri:

3. Huolestuttaako ympäristön tila, erilaiset ympäristövaikutukset ja ilmastonmuutos sinua henkilökohtaisesti?
4. Pidätkö ympäristövaikutusten huomioon ottamista tärkeänä, kun suunnitellaan ICT-ratkaisuja älykkään matkailun kehityksessä?
5. Uskotko, että pystyt omilla toimillasi vaikuttamaan ympäristön tilaan? Miten?
6. Esiintyykö työympäristösi kielenkäytössä ja kommunikoinnissa kestävään kehitykseen liittyvää sanastoa?

IT:n suorat vaikutukset:

7. Miten vihreä suunnittelu, valmistus, käyttö ja hävittäminen näkyvät hankkeessanne?
8. Otetaanko hankintapäätöksissä huomioon tuottajan ekologisuus? Suunnitellaanko IT:n käyttö energiatehokkaasti?
9. Pyritäänkö teknologiaa uudelleenkäyttämään tai kierrättämään? Onko teknologian hävittäminen hoidettu mahdollisimman pienin ympäristövaikutuksin?

IT:n mahdollistavat vaikutukset:

10. Onko hankkeessanne painotettu sellaisia ICT-järjestelmiä ja ratkaisuja, jotka auttavat vähentämään negatiivisia ympäristövaikutuksia eri liiketoimintaprosesseissa?

IT:n systeemiset vaikutukset:

11. Tehdäänkö teidän kehityshankkeessanne toimia, jotka kasvattavat tai luovat ympäristöaiheista tietoisuutta? Miten?
12. Uskotko, että teidän kehitysprojektissanne käytetyt ICT-ratkaisut ohjaavat käytöksen tai prosessien muutokseen? Miten?

Strategiat ja käytänteet:

13. Onko kehityshankkeessanne määritelty tavoitteet ICT:n kestävälle kehitykselle?
14. Onko kehityshankkeessanne määritelty kestävän kehityksen strategia ICT:lle? Jos on, onko se sopeutettu yhteen liiketoimintastrategian kanssa?
15. Onko kehityshankkeessanne määritelty yleisiä käytänteitä ICT-ratkaisujen kestävyyteen liittyen, kuten hankintojen, käytön ja hävittämisen osalta?

Hallinto ja johtaminen:

16. Onko käytössänne standardeja tai mittareita, millä pyritte seuraamaan kehityshankkeenne ICT-ratkaisujen kestävyyttä?
17. Onko hankkeessanne määritelty, kuka on vastuussa kestävän kehityksen seurannasta ja toteutumisesta?