GREEN IS
— A SYSTEMATIC LITERATURE REVIEW

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Abstract

This thesis provides a systematic literature review of a selection among current papers and articles on Green Information Systems (IS). The main focus is on the current state of Green IS in academic research. This study aims at gaining a deeper understanding and a clearer view of the state-of-the-art of IS for environmental sustainability research, with the goal of clarifying the diffuse idea of what Green IT/IS is, and what differentiates Green IS from Green IT.

To support the objective of this study, the articles selected for data analysis were collected by using a systematic literature review as research and analytical method. Within the thesis, a descriptive angle with an interpretative character is used to analyse the data extracted.

A theoretical framework based on concepts from sustainability, Green IS and Green IT is employed in order to analyse and compare terminologies and frameworks used in the studied articles. Furthermore, the different dimensions of sustainability and the various terms used to describe Green IS are analysed comparatively.

The result and analysis are discussed in a conclusion confirming the on-going ambiguity of the terms Green IT and Green IS and the transformative power of IS. This study aims to contribute to our understanding of some of the existing problems that hinder further research in the context of Green IS. Finally, we emphasise the importance of clear definitions in order to advance the IS position for transforming society in a sustainable direction.

Keywords: Environmental sustainability, Information system (IS), Information technology (IT), green, systematic literature review, Green IS
Sammanfattning

Uppsatsen avhandlar ämnet Green Information Systems (IS) med fokus på aktuella publikationer inom området. En systematisk litteraturöversikt har genomförts för att belysa ämnet och skapa en klar bild och djupare insikt om nuläget inom miljömässig hållbarhetsforskning, förklara betydelsen av termen Green IS/IT och klargöra vad som särskiljer Green IS från Green IT.

Artikelurvalet i studien är utförd med hjälp av litteraturöversikten som analytisk metod. I uppsatsen används en deskriptiv vinkling med interpretativ karaktär för att analysera den insamlade informationen.

Ett teoretiskt ramverk som bygger på begreppen om hållbarhet, Green IS och Green IT ligger till grund för analysen och används även för att jämföra och bedöma terminologi och ramverk mellan de utvalda artiklarna. Vidare har även begreppet hållbarhets olika dimensioner inom Green IS samt de termer som används för att beskriva Green IS i artiklarna analyserats jämförelsevis.

Slutligen diskuteras resultatet och analysen i en sammanfattning som bekräftar den tvetydighet som råder kring termerna Green IS och Green IT, men även understryker den transformativa kraft som finns inom IS. Studien syftar till att skapa en förståelse för de svårigheter och problem som utgör hinder för fortsatt forskning inom Green IS. Avslutningsvis betonas vikten av tydliga definitioner för att IS i framtiden skall kunna spela en ännu större roll inom hållbar utveckling i samhället.

Nyckelord: hållbar utveckling, Informationssystem, Informationsteknologi, Grön IT, Systematisk litteraturöversikt, Grön IS
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1 Introduction

The information and communications technology (ICT) industry accounts for about 2-3% of the global carbon footprint (Mingay & Pamlin 2008; Reimsbach-Kounatze 2009). Figure 1 shows that the main sources of ICT’s carbon footprint are from the use of personal computers and data servers (Mingay 2007). They contribute to environmental degradation through energy generation and waste disposal throughout the IT product lifecycle. Information Technology produces 4 million tons of carbon dioxide (CO₂) every year (Ranganathan 2010).

![Figure 1. ICT’s global carbon footprint. From data in (Mingay, 2007)](image)

The impact of Information systems (IS) can be seen as twofold. IS contributes to enormous carbon emission, worsening global warming and climate change (Stocker, Dahe & Plattner 2013). At the same time, it is a potential solution for reducing energy consumption and assisting organisations to be more sustainable on both corporative and environmental levels.

The traditional way of doing business focusing on economical benefits is considered to be a threat to global sustainability (Cartwright & Craig 2006). At the same time, adoption of Green IT initiatives has resulted in cost saving due to energy efficiency measures and waste reduction. Traditional IT adoption is usually motivated by foreseeable economic benefits while the Green Information Systems adoption is motivated by both economic as well as environmental benefits (Molla 2009). Standing & Jackson (2007) argue that IS plays a leading role in enabling innovations in sustainable development and achieving both economic and environmental target within organisations.

More and more organisations work on improving their environmental profile and such development continues to grow in the foreseeable future. Regardless of what factors may be motivating this positive trend, be it customer pressure, green profiling as a marketing tactic,
perceived competitive advantage or something else, there is one clear winner – the environment.

The trend of implementing Green IT in organisations has grown from being solely focused on technical infrastructure to including the wider systemic processes that fall under the label Green IS. The need to address the twofold nature of Green IT and IS has been recognised amongst both practitioners as well as scholars (Elliot 2007). However, the blurry definitions of Green IT/IS might hinder further development in Green IS research (Loeser, Erek, Limbach, et al. 2013). It is suggested that a clear definition of the terms path the way for well-grounded theories in emerging research area (ibid.).

With the goal of clarifying the diffuse idea of what Green IT/IS is and what differentiates Green IS from Green IT, this study provides a systematic literature review of relevant IS articles in order to present and analyse the status of Green IS research.

1.1 Research Overview

The concepts of Green IS/IT/ICT and sustainable IS/IT/ICT have been used interchangeably by different researchers (Ijab, Molla, Kassahun et al. 2010; Mithas, Khu & Roy 2010). Concerning “Green”, some refer to it as “sustainability” while others prefer “eco-sustainability” or “Green” (Chen, Boudreau & Watson 2008; Murugesan 2008).

IS is considered to cover a wider scope than IT. IS is often referred to as a set of computational and software tools (IT) used by people for achieving their goals within an organisation. On the other hand, IT is commonly defined as the technical infrastructure for information systems (Ijab, Molla, Kassahun et al. 2010). Since we focus on such differences between IS and IT, the term Green IS is used in this study to cover organisational processes for enhancing the environmental performance between stakeholders and IT within an organization, whereas Green IT is used to describe the technical equipment that support the Green IS practices and processes.

Sustainable development is defined as “the development that meets the needs of the present world without compromising the ability of future generations to meet their own needs” (Brundtland 1987, p.24). There are three aspects to sustainable development, namely the economic, social and ecological aspects. Sustainability also plays a crucial role in the survival of organisations in the long run (Porter & Kramer 2006). In order to leverage business competitiveness, organisations must look beyond mere economic benefits and focus on both social and environmental impacts and benefits such as cost reduction, high profitability and energy efficiency (Porter & Kramer 2006; Dao, Langella & Carbo 2011). Smith & Sharicz (2011) stress the importance of having a clear and realistic business plan that can be followed.

Environmental goals are commonly found as part of the organisations’ Corporate Social Responsibility (CSR) in a way that environmental and social aspects are closely related
The economic, environmental and social impacts of the organisations are often reported in their CSR reports as part of the “triple bottom line” (Standing & Jackson 2007; Dao, Langella & Carbo 2011).

IS researchers and practitioners have recently started to explore the potentials of Green IS due to its significance in enabling environmental targets and sustainability in business as a whole (Dao, Langella & Carbo 2011). In fact, Green IS has been considered to be one of the top research topics in the future of IS research (Baker, Avital, Davis, et al. 2011). Therefore, it is crucial for IS professionals and practitioners to have an understanding what impacts IS and IT have on the environment (Smith & Sharicz 2011). Having a better understanding on how IS can contribute to raise environmental consciousness and environmental-friendly work. With the help of IS, organisations can adopt eco-sustainable initiatives within a shorter time (Chen, Boudreau & Watson 2008).

In this study we will use the concepts Green IS as well as environmental sustainability to avoid confusion between different terms. With environmental sustainability, the organisations have to consider not merely the economic benefits but also the environmental impacts and benefits in their operations.

1.2 Problem Discussion & Research Objective

Utilising IS to support and enable ecological sustainability is a relative new area; therefore much of the previous research is concerned with theory development and the application of conceptual frameworks. The lack of consensus within the research field in defining and differentiating the terms Green IS and Green IT has been acknowledged by IS researchers (Molla 2009; Loeser, Erek, Limbach et al. 2013), resulting in difficulties in further research development in the area (Smith & Sharicz 2011; Ryoo & Koo 2013). This is unfortunate, since further research is crucial to the future role of IS and IT in contributing to and resolving environmental sustainability issues (Molla 2009; Melville 2010). To better understand the roles of IS in the context, more research is needed on how IS is being defined and researched to support environmental sustainability goals.

Based on these assumptions, the purpose of this study is to present the current state of Green IS research to practitioners and researchers. Our beliefs are, that with the ever-increasing awareness of environmental issues, it is timely to study the current state of Green IS initiatives and the roles of IS to the sustainability issue.

Any Green IS initiative, no matter how ambitious, can only have an effect if it is actually adopted, thus this research is concerned with the question of how Green IS constructs are being defined and interpreted in the context of sustainability. On the basis of the purpose and the theoretical assumptions the following research question has been formulated:
How can we, by using systematic literature review, reach an understanding of what differentiates Green IS from Green IT?

In order to answer the research question, we propose the following specific research questions;

*Given the current state of Green IS in academic research, what is the span of research within the field?*

*To what extent are the different dimensions of sustainability studied?*

### 1.3 Outline

**Chapter 1 – Introduction**
The first chapter introduces a brief research background. It outlines the purpose of this study with the research questions presented. This is followed by a problem discussion, explaining the motivation of conducting this study and its relevance to IS field.

The aim of the introduction is to present the background and motivations of conducting the study in relation to its potential relevance to IS research.

**Chapter 2 – The Scope of Sustainability and Green IT/IS**
This chapter presents the theoretical aspects of our study. Relevant theories and research are presented. First, we describe the different dimensions of sustainability and how they are related to Green IS. Then we continue with distinguishing the two constructs Green IT and Green IS. This chapter ends with a presentation of the Green IS Lifecycle Framework, which is part of our analytical framework.

**Chapter 3 - Methodological Choices and Analytical Framework**
The third chapter presents the methodological choices we made in this study. It starts by describing the research process and is followed by a detailed presentation of the research methodology – Systemic Literature Review. Based on the systematic literature review, we describe the research method, search strategy, search process, data collection and extraction methods as well as data synthesis method. This chapter ends with a method evaluation for this research.

**Chapter 4 – Result of the Systematic Literature Review**
This chapter presents the findings from the conducted systematic literature review. It aims at organising and analysing data in a meaningful way in order to answer the research questions presented in the Introduction chapter.
Chapter 5 – Analysis of the Systematic Literature Review

The result of the systematic literature review is compared and analysed in this chapter. The aim of chapter 5 is to serve as one of the bases for the discussion and conclusions in the following chapter.

Chapter 6 – Conclusions & Discussions

The final chapter concludes our findings and provides a discussion around the stated research questions. The further implications of the findings to the assumptions underlying our research questions as well as to the general practice of IS research are explored. In closing, some new questions and ideas for further research in these areas are presented.
2 The Scope of Sustainability and Green IT/IS

In the introduction, we highlighted the possibilities of utilising IS for leveraging environmental sustainability and the need to identify relevant studies that concern Green IS research. This chapter gives a description of the theoretical basis, which is useful and serves as a set of tools to facilitate our research methodology and theoretical analysis. First, we describe the different dimensions of sustainability and how they are related to Green IS. Then we continue with distinguishing the two constructs Green IT and Green IS.

2.1 Sustainability

Sustainability is a complex concept that is not fully understood (Mulvihill & Milan 2007; Chen, Boudreau & Watson 2008), and sustainability has a variety of definitions. It is a word that is given an extrinsic meaning based on different contexts. Being in use along with, for example, different frameworks, policy and compliance, sustainability can have different meanings and be interpreted in various ways. When a frame of reference changes, the interpretation of concepts and theories of what sustainability is transforms accordingly (Standing & Jackson 2007). Thus, when referring to sustainability, one has to define the context and dimension to give it an intrinsic meaning. As a multidisciplinary field, sustainability remains a complex concept that manifests in a variety of definitions and conceptualisations (Elliot 2011).

The idea of sustainability was introduced by the World Commission on Economic Development in the Brundtland Report (1987). There, it is defined as the study of the relationship between economic growth and the environment. Sustainable development was defined as "development that meets the needs of the present world, without compromising the ability of future generations to meet their own needs" (Brundtland 1987, p.24).

The UN definition of sustainability consists of three dimensions - *environmental protection*, *economic development* and *social equity*. They are interdependent to each other in a way that in order to have economic growth, the society has to develop with a balanced and sustainable environment (Ijab 2011).

A clear definition and rich understanding of sustainability is required for organisations to succeed in their work in corporate sustainability. Smith & Sharicz (2011) shows that many managerial level employees have little idea what sustainability means. If the managers have little understanding of it, it is hard for the rest of the organisation to follow any sustainability initiatives (Smith & Sharicz 2011). It is, therefore, important that the term sustainability is well-defined within organisations in order to work towards a common and explicit goal.
Previous literature (Molla 2008) argues that the goals with IS for environmental sustainability are pollution prevention, product stewardship, and clean technology after adopting Hart’s (1997) criteria of environmental sustainability. It is through goals with sustainability that the work with Corporate Social Responsibility (CSR) and Triple bottom line (TBL) has emerged (Molla 2008).

Corporate Social Responsibility (CSR) was one of the first concepts to bring social responsibilities and align them with ethical and international standards. From the mid-1970s, organisations have been distributing CSR reports (Smith & Sharicz 2011). However, similar to the definitions of sustainability, a simple distinct definition of CSR does not exist (ibid.).

In order to ensure clarity in communication, some have attempted to define CSR in their contexts. According to Matten & Moon (2007, p.179), CSR is a "cluster concept, which overlaps with such concepts as business ethics, corporate philosophy, corporate citizenship, sustainability and environmental responsibility". This definition is argued to be one of more comprehensive (Babin & Nicholson 2009) suggesting CSR's connection to sustainability and environmental practices. It is up to the organisations to voluntarily adopt the definitions as part of their goals and work towards them. Recognising the relation between CSR and environmental responsibility, the results of organisations' environmental efforts can therefore be found in the CSR reports (Matten & Moon 2008).

Since there is no clear definition of what CSR is, there is thus no clear guideline to how organisations can adopt CSR and comply with CSR (Smith & Sharicz 2011). Similarly, a lack of tools for measuring CSR contributes to the difficulties in comparison and follow-up of the organisations' effort and progress. Moreover, it is not practical to have a measurement tool unless a majority of organisations want to adopt it in order to compare their CSR efforts with those of others.

According to Smith & Sharicz (2011), TBL is a concept that integrates economic, social and ecological sustainability of doing business. The term TBL was first coined by Elkington (1994) and has been gaining more and more popularity in the recent years. This approach proposes that besides economic efficiency, organisations should also engage in activities, which are positive to the environment and society (Elkington 1994). Sustainability has become increasingly important in business research to evaluate the impact on the environment and other stakeholders. TBL does not just look at the economic context of sustainability. The relationship between the three bottom lines is illustrated in Figure 2.
Some discuss that there are still organisations that aim at single bottom line, which focuses on the economic sustainability only (Chen, Boudreau & Watson 2008; Unhelkar 2011). However, a single bottom line focus in which economic interest is a prime driver is not sustainable in the long run (Chen, Boudreau & Watson 2008).

Fadhilah & Ramayahb (2012) argue that an increasing awareness of sustainability creates a demanding citizenship, who demand that organisations balance social and environmental goals along with the organisations’ long-term viability. In order to survive long-term, organisations are required to undertake sustainable practices that are beyond mere economic interests.

According to Butler (2011), more and more organisations measures their impacts with TBL, which means that they have environmental and social responsibility for what they do, in addition to the economic interests to maximise profits. It is a paradox that an organisation has to be financially viable in order to be able to adopt social and environmental sustainability (ibid.).

Standing & Jackson (2007) propose that CSR create TBL as a result of indicators of how well the organisations have worked towards the sustainability goals. Smith & Sharicz (2011) point out that some organisations make use of TBL simply as documents that indicate their efforts towards sustainability as good will. Therefore, using TBL as an indicator of how well they have done in implementing their efforts can easily be a paper without any practical work that fulfils the requirements (ibid.).

In the past, environmental-friendly products have been considered unnecessary extra costs instead of a source for gaining competitive advantage (Sarkis, Koo & Watson 2013).
According to Chen et al. (2008), ecological sustainability has recently risen to prominence as a solution to environmental and social problems. It is an important research area that hopefully will change our approach and behaviour towards environmental sustainability (Melville 2010).

There has been little research on the relationship between ecological sustainability and IS (Molla 2009; Melville 2010), which is noteworthy because the revolutionary development and the impact of IS on society and people should be studied in a greater extent and depth (Melville 2010). The implementation of IT and the associated systems has enabled higher efficiency and productivity, which also led to more pressures on the environment (Sarkis, Koo & Watson 2013). On the contrary, it can limit pollution by offering electronic platforms for services as well as through design and energy-saving measures (Cooper & Molla 2013; Butler 2011; Melville 2010).

Ecological sustainability affects everyone, every organisation and society, therefore everyone has to take responsibility for what they do that impacts the environment (Cooper & Molla 2013). Can IS be part of the solution? Melville (2010) proposes that IS researchers can contribute to the development of IS for ecological sustainability. Through research, IS can provide part of the solution for ecological sustainability. It will shorten the time for organisations to achieve ecological sustainability if both researchers and practitioners have better understanding of how IS can contribute to environmental awareness and eco-friendly efforts (Chen, Boudreau & Watson 2008). Organisations’ long-term sustainability will benefit from this (Seidel & Recker 2012).

The term green washing is from time to time highlighted in the media. It describes a practice of organisations employing a green image as a facade without actually employing any real change for reducing their environmental impact (Molla 2013). Organisations may have concerns about their products that do not live up to customers’ expectations and thereby create a green identity merely for attracting customers (Melville 2010). As a counterpoint, another phenomenon known as “Green Up” describes the process when organisations request their suppliers to be “green”, which triggers a pushing force to both processes and products to be green (Murugesan 2008). This initiative encourages suppliers to become greener. Similar action can be observed in governmental authorities when they only use suppliers that are green, enabling a greener supply chain (Watson, Boudreau, Chen et al. 2008). This is an effective way to ensure the entire supply chain to be green (Bose & Luo 2011; Malhotra, Melville & Watson 2013; Ryoo & Koo 2013; Unhelkar 2011). However, bigger organisations tend to be able to adopt these initiatives more quickly than smaller one. Thus, it is important that state-owned companies or large organisations take the initiative and become the driving force for improving ecological sustainability.
2.2 Green IT

IT and IS has a potential power to turn our society into a more sustainable one (Fuchs 2008). In the last few decades, IT has brought a tremendous change into the way we live and work. Productivity has soared with the use of computers and their subsystems. As mentioned in the introduction, the role of IT/IS in leveraging environmental sustainability is twofold. The use of IT has been a significant contribution to pollution and energy overconsumption (Elliot & Binney 2008). The use of IT is accounted for 2% of the total CO₂ emission in the USA (Mingay 2007). The focus on energy efficiency in data centres and hardware has been criticised as an improvement with limited results. In France, electricity consumed by the use of IT is estimated at 13.5% of the total consumption in despite of continuous efforts to improve energy efficiency equipment (Faucheux & Nicolaï 2011). A growing number of data centres is argued to be the main culprit (ibid.).

Green IT definitions come with a great variety in terms of understanding, conceptualisation and terminology. This lack of consensus in definition beclouds the view of the subject (Erek, Schmidt, Zarnekow, et al. 2009). Murugesan (2010) refer Green IT to the efficient and effective use and manufacture of IT-enabled technologies with minimal environmental impacts. This focuses on energy efficiency improvements through the implementation of virtualization, energy-saving computer products and cooling systems for data centres.

Ijab et al. (2010) define IT as the technical infrastructure for information systems. Those who differentiate Green IT and Green IS usually consider IT as a source of environmental problem while IS as a solution for reducing the environmental degradations caused by the former.

Viewed from the perspective "IT as a problem", Green IT practices are design, manufacture, operation and IT disposal with an aim of reducing negative environmental impact (Murugesan 2008; Loeser, Erek, Limbach et al. 2013). Whereas Bose & Luo (2011, p.38) refers to Green IT as “the using of IT resources in an energy-efficient and cost-effective manner.”

There is a fundamental difference between the two definitions. In the first definition, design is considered to be an important component of Green IT. In contrast, the second one omits the design phase and focuses on the operating and use of IT resources, such as personal computers, printers and data centres.

In line with Melville (2010) and Brundtland (1987), the definition of Green IT we use in this study is the study of the production, application, operation, and disposal of IT and IT-enabled products throughout their life cycle with minimal or no negative environmental impact.
2.3 Green IS

IS refers to a set of computational software tools (IT) used by people for achieving their goals within an organisation (Faucheux & Nicolaï 2011). This suggests that the scope of IS is much wider and bigger than IT. IT provides the technological tools to support the functions and activities stakeholders need to reach their goals within an organisation boundary. In the other word, IT is the "hardware, software and peripheral equipments" (Ijab, Molla, Kassahun et al. 2010, p.434) which form part of the information systems. Besides IT, IS emphasises the communication between stakeholders within an organisational boundary. The shared services and communications enabled by IS applications such as Enterprise resource planning (ERP) and Customer relationship management (CRM), aim at improving efficiency and effectiveness and thus increase productivity inside organisations. For instance, ERP systems consolidate and streamline all the sub-systems into a common system that is used by staff throughout an organisation. It usually shares a data depository so data duplications have largely been reduced. Hence, the role of IS in supporting organisations to become more sustainable in both business as well as environmental sense has gained a lot of attention in recent years. Melville (2010) states “information systems are an important but inadequately understood weapon for environmental sustainability”.

Using Green IS applications is not enough, having the understanding of it is more important. Specifically, having implemented Green IT/IS does not necessarily lead to a green business as shown in Figure 3. Organisations must understand how the technologies can facilitate business process changes so that they can:

- understand the change capacities
- understand the implications of the change
- manage the change itself (Seidel, Recker & Brocke 2012)

![Figure 3. Relationship between Green IT/IS and Green Business (Seidel, Recker & Brocke 2012)](image)

In line with the spirit part of the Green IS Lifecycle, it has to be internalised and adopted by managers, the employees’ mind/spirit to achieve the Green IS-enabled business changes which are beyond the dedicated IT for environmental sustainability. Seidel et al. (2012) place
focus on human assets and view them as important as IS in enabling the transformation to sustainable practices and solutions.

According to Ijab (2011), the role of IS for environmental sustainability can be classified into an enabler, a promoter as well as a transformative power. An enabler role is to induce changes in the business processes while a promoter role is to change the way staff and organisations perceive and behave (Ijab 2011). Furthermore, IS as a transformative power can transform society into an environmentally sustainable one (Watson, Boudreau & Chen 2010).

IS plays an important role in the design, implementation and execution of sustainable business processes (Seidel, Recker & Brocke 2012). Apart from the obvious business efficiency gained by Green IT practices, the motivations for putting them into actions can arguably categorised into five categories - environmental, compliance, ethics, financial, competitiveness (customer demands) (Loeser, Erek, Limbach et al. 2013).

2.4 Green IS Lifecycle

Ijab et al. (2010) argue that the Green-ness of Green IS appear from the perspectives of spirit, practice and impact. It is inscribed in the design and development stage and through the Green IS practice, and come out as impact (as output). They suggest that the evidence of Green IS practice can only be evaluated in the post-use stage when the organisation evaluate and assess the actual improvement in their environmental performance. In the Green IS Lifecycle Framework, Ijab et al. (2010) conceptualise Green IS. This encapsulates and captures the what, where, how, when to inscribe “Greenness” in Green IS”. The emphasis on the human aspect (spirit) concur with the human-centric view shared by Seidel, Recker & Brocke (2012).

![Green IS Lifecycle Framework](image)

*Figure 4. Green IS Lifecycle Framework (Ijab et al., 2010; adopted from Diez & McIntosh, 2009)*
3 Methodological Choices and Analytical Framework

This part provides a description of our choice of research method on the basis of chapter one and two. First, we present the procedures of this research. Then, we present how we proceeded with systematic literature review as our research and analytical framework. Finally, we evaluate the research methodology and discuss the limitations that came up with this choice of method.

3.1 Research Process

Research processes for this study and their relationships with each other is illustrated in Figure 5.
Following our research questions, we began to explore what had been researched on Green IS. We found that the existing literature had a strong emphasis on green IT. In contrast, the term Green IS generated much fewer results in academic databases and search engines.

During the initial literature review, we searched in the databases including Borås University library catalogue Summon, ACM Digital Library, IEEExplore, ScienceDirect and SpringerLink. The keywords used were green, green IT, green IS, sustainability, CSR, environmental sustainability, ecological sustainability, environmental, environment.

As new ideas often appear in academic conferences, a literature search in IS conference proceedings was also carried out. The conferences selected were Australasian Conference on Information Systems (ACIS), European Conference on Information Systems (ECIS), International Conference on Information Systems (ICIS) and Pacific Asia Conference on Information Systems (PACIS). The same keywords were used in the search. In order to familiarise ourselves with reliable information, various research papers were selected based on the number of times they were being cited by other Green IS researchers. The benefits of reviewing literature are to get a better understanding of the relationship between ecological sustainability and IS, and to discover the gaps of the previous academic research (Bryman & Bell 2011). Our initial literature study fostered our understanding of what previous work had covered and what was left to do.

While going through the related literature, we discovered that there has not been any consensus on the definitions and components of Green IT/IS. As it is argued in Section 2, academics and practitioners have used the terms Green IT and Green IS interchangeably. The ambiguity of it hinders further development in new research areas (Elliot 2011). Moreover, many IS researchers propose that Green IS had been under-researched and required further studies (Molla 2009). Therefore, we sensed the potentials of analysing the current state of information systems for leveraging environmental sustainability with the help of a deeper and more thorough literature review - systematic literature review. Systematic literature review was chosen to be data collection and synthesis method. The following section 3.2 presents the processes and details of the systematic literature review we conducted.

At the same time, we made use of the results from the initial literature search for finding appropriate theories and models that became part of our research framework. These two processes were done in an iterative manner. There is a continuous interplay between the collection of relevant theories and/or models and developing the framework.

The framework first guided us to develop more specific questions that were used in the systematic literature review, data collection, result analysis and validations. As a result, the research framework was applied throughout the whole research process and assisted us to process the findings and answer our research questions.
3.2 Using Systematic Literature Review as Research Method

Systematic literature review is a form of secondary study (Kitchenham 2004). The studied papers contributing to the systematic review are considered primary studies.

Systematic literature review has been widely used within health and medicine research for decades but it has only started to be used outside these areas in recent years (ibid.). One of the reasons systematic literature review has become more and more popular is due to the vast amount of digital information available and thus it is not possible for researchers and practitioners to review the materials they are after.

Unlike traditional literature review, systematic literature review offers a fairer synthesis on the existing studies (ibid.). For example, a predefined search strategy must be followed when performing a systematic review. System review is also different from the traditional literature review in its scope and rigour.

A series of processes undertaken in this systematic literature review is presented in Figure 6.

![Figure 6. Processes of Systematic Literature Review](image)

The goal of this study is to find out what research has been done on Green IS and to answer our overall research question - *How can we, by using systematic literature review, reach an understanding of what differentiates Green IS from Green IT?* We identify and classify them with the help of the theoretical bases presented in Section Taking advantage of the systematic literature review, we can focus on what IS academics have been researching on Green IS. This can provide a valuable overview of the status of IS research on green IS and a guide for further potential studies.

Using a systematic review methodology provides a way for differentiating the present research evidence. Moreover, the systematic literature review allows us to study and analyse from multiple studies of high quality since this study requires analysis based on the multifaceted sides of Green IS.

3.2.1 Identification of Review Questions

Based on our research questions under section 1.2, further specific review questions were identified in order to execute the systematic literature review. These review questions guide us to design our search strategy and most importantly what kinds of data we are going to
extract from the identified papers. Therefore, we composed the following review questions to assist the literature review.

- What research has been conducted, and where and when was it published?
- What research questions have been asked and what were the findings?
- Which theoretical frameworks and theories have been employed?
- What is the role of IS in Green IS research?
- What Green IS concepts have been employed and how were they defined?
- Which dimensions of sustainability have been studied?

### 3.2.2 Review Protocol

The review protocol for a systematic literature review is a list of tasks to be performed for answering the specific research questions in section 1.2.

It is considered to be an important part of the systematic literature review. Not only does it provide a common standard amongst the reviewers, it also lays down the foundation for the search process, data extraction and data synthesis processes. It is argued that creating a review protocol can provide better planning beforehand and force the reviewers to critically evaluate the steps followed before they begin (Okoli & Schabram 2010). Therefore, before beginning our SR, we created a review protocol, which is summarised below.

In this study, only two people review the papers, implying that there is a small need to have a thorough and detailed review protocol as suggested by Kitchenham & Brereton (2013). Hence, a simple review protocol is used in the proportion to the time limit and the size of this study.

### 3.2.3 Search Strategy

The following describes the process of search strategy, including keyword definition, query string definition, data sources and search procedure.

**Keywords Definition**

Keywords are identified with the help of research question formulation and the initial literature review. Keywords identified in the primary studies were used for assessing other key terms and related terms or synonyms.

First we planned to search with keywords *green IS, green IT, sustainability, environmental sustainability* and *environmental*. During the review process, it became apparent that some articles have extended the coverage of Green IS and proposed a construct called sustainability/sustainable innovation. Since we already had sustainability and sustainable as part of the search string, the search generated by them cover sustainability/sustainable innovation as well. The results of keyword identification are shown in Table 1.
Query String Definition

Search strings are formed using Boolean “OR” to connect the related synonyms and “AND” to include the three sets of keywords shown in Table 1.

Table 1. Keywords used in Data Search

<table>
<thead>
<tr>
<th>Information Systems</th>
<th>Green</th>
<th>Dimensions of Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information systems (IS)</td>
<td>Eco-sustainability</td>
<td>Triple bottom line (TBL)</td>
</tr>
<tr>
<td>Information technology (IS)</td>
<td>Sustainability</td>
<td>Corporate social responsibility (CSR)</td>
</tr>
<tr>
<td></td>
<td>Sustainable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ecological</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Green</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thus, the resulting query strings are:

QS1 (“information systems” or IS or “information technology” or IT) AND (eco-sustainability OR sustainability OR sustainable OR environmental OR ecological or green) AND/OR (“Triple bottom line” or “Corporate social responsibility” or “CSR”)

QS2 is applied for targeting the papers that have specific focus on green IS in a way that they use the exact construct “Green IS” or “Green IT”.

QS2 (“green information systems” or “green IS” or “green information technology” or “green IT”)

Data Sources

In Table 2 below a list of journals, conferences and databases in which we perform our literature search are presented.

Table 2. Journals, conference proceedings and databases searched in this review

<table>
<thead>
<tr>
<th>Journals</th>
<th>Conferences</th>
<th>Databases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Systems Research</td>
<td>Australasian Conference on</td>
<td>ACM Digital Library</td>
</tr>
<tr>
<td>Journal of Management</td>
<td>Information Systems</td>
<td>EBSCOHost</td>
</tr>
<tr>
<td>Information Systems</td>
<td>European Conference on</td>
<td>Emerald Insight</td>
</tr>
<tr>
<td>Australasian Journal of Information</td>
<td>Information Systems</td>
<td>IEEExplore</td>
</tr>
<tr>
<td>Systems</td>
<td>Hawaii International Conference on</td>
<td>ProQuest Computing</td>
</tr>
<tr>
<td>Business &amp; Information Systems</td>
<td>System Sciences</td>
<td>Summon (Högskolan i Borås)</td>
</tr>
<tr>
<td>Engineering</td>
<td>International Conference on</td>
<td>ScienceDirect</td>
</tr>
<tr>
<td>Business &amp; Society</td>
<td>Information Systems</td>
<td>Scopus</td>
</tr>
<tr>
<td>Communications of the Association</td>
<td>Pacific International Conference on</td>
<td>SpringerLink</td>
</tr>
<tr>
<td>for Information Systems</td>
<td>System Sciences</td>
<td></td>
</tr>
<tr>
<td>Information and Organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information System Frontiers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journal of Computer Information Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journal of Strategic Information Systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Journal of Systems and Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management Information Systems Quarterly</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Search Process

The search process began with a manual search of specific IS journals and conference proceedings papers published between 2007 and 2014. The selected IS journals and conference proceedings are shown in Table 2.

The start year 2007 is chosen because the term “Green IT” was found to be used for the first time in 2007 (CIO Magazine, 2007). As our focus is on the recent and current development in Green IS research, it is appropriate to start from the period when the constructs became known and used by researchers, which was the year 2007 (Murugesan 2008).

To assure the primary studies are of good quality, we further filtered our search results in peer-reviewed journals and quality conference proceedings.

Searches were performed on Scopus, Summon (University of Borås) and Emerald Insight. At first, initial searches were performed on Summon (University of Borås library). However, it appeared that the links to other databases on Summon were not always updated. For example, articles, which are available for full text on a database that Summon links to can appear to be unavailable in the result on Summon. Moreover, the search strings presented previously could not be used on Summon due to the restrictions on the default configurations. After conducting the general searches on Summon, we proceeded to Scopus and Emerald Insight for more specific searches.

A combination of the three databases covers the listed journals and conference proceedings (shown in Table 2). Hence, there was no need to search in each individual journal database.

3.2.4 Inclusion and Exclusion Criteria

This study targeted peer reviewed journal articles as well as conference proceedings articles on the current state of Green IS, published between January 1st 2007 and March 31st 2014. The following criteria were used to select articles for inclusion:

- A study is related to Green IS.
- Articles are written in English.
- Articles are published in the listed journals and/or conferences in Table 2.
- Citation Index (Science Citation Index Expanded and citation index on Scopus)

Citation Index provides a pointer to which articles are more regarded and thus a good reference for screening and selection articles of good quality. Both Science Citation Index (SCI) Expanded and Scopus citation index are used for sorting due to the fact that a higher
reliability and coverage can be reached with a combination of the two significant citation databases.

Articles were excluded based on the following criteria:

- A study is about sustainability in relation to IS that only concerns social and/or economic aspect of sustainability.
- Papers of the same study but were published in different journals or conferences.
- Articles that are not in the Table 2.
- Articles that did not match the inclusion criteria.

When the relevant articles were selected, we screened them against the inclusion and exclusion criteria. Then we removed duplicated papers and began reading the full text of the selected papers.

### 3.2.5 Data Collection & Extraction

The following are the data points extracted from each article selected for inclusion:

- Source (journal or conference proceedings)
- References
- Authors
- Countries of locations
- Research methods
- Theoretical frameworks and/or theories employed
- Main topic area/ focus
- Research questions
- Use of the terms Green IT/IS and the definitions used
- Use of the concept sustainability in relation to Green IS
- Summary of the study

Following Kitchenham’s advice (Kitchenham 2004), one researcher extracted the data and another checked the extraction. When disagreements arose, we discussed the issues until agreement was reached.

### 3.2.6 Data Synthesis (Analysis)

The data extracted from the primary studies analysed qualitatively through tabulation, organisation, comparison and discussion (Okoli & Schabram 2010). Relevant information extracted from the studies was tabulated in a way that is consistent to the research questions. Similarities and difference between in extracted information are highlighted in the tables to facilitate further comparison and discussion (Kitchenham 2004). For instance, to provide an
answer to the number of publications per year, the difference in the number between journal articles and conference proceedings is highlighted in a chart.

Okoli & Schabram (2010) argue that a systematic review is always shaped by subjective interpretation because the data collected is to be interpreted by reviews and thus influenced by their preconceptions. A descriptive data synthesis is chosen to summarise the results of the systematic review.

3.3 Research Quality

Qualitative studies are generally subjective because the data collected is to be interpreted and hence influenced by the researchers’ preconceptions.

In regard to reliability, it has to do with if the findings of the study could be repeated and replicated in other settings with a similar baseline. It is important that during all stages of the research process, complete records are kept to enable replications of the findings (Bryman & Bell 2011). In this review, all the steps and results are recorded in the form of a research diary and spreadsheets. The description of the method process is written in a relatively extensive level as required in SR, allowing the possibility for the search process to be replicated.

When we encountered uncertainties about inclusion and/or exclusion of some papers, we discussed our disagreements until it was resolved. Throughout the research process, we kept records of the research procedures, techniques, methods and the decisions we made. This aimed at achieving external reliability by keeping a high level of transparency.

When systematic review is done thoroughly with a substantial amount of primary studies, the language bias is likely to be avoided (Kitchenham 2004). However, a complete systematic review requires a much longer timeframe and more effort than we are able. Therefore, this study possibly has more bias than other studies applying systematic reviews.

In order to minimise systematic bias, extra efforts were made. For example, we searched in not only academic journals but also conference proceedings databases to cover the most recent IS research and other work-in-progress research. When we selected papers for inclusion, we sorted them in the order of citation index based on both Science Citation Index and Scopus citation index for a better coverage. It is considered to be more reliable when both sources are employed (Kitchenham 2004).

3.4 Limitations & Delimitations

Due to the time constraint, the number of papers reviewed is kept relatively small though they all play an important role in shaping and developing the research on Green IS and in answering the research questions in this review.
Systematic literature review in its original form is rigorous in scope, which requires a much longer time (Kitchenham 2004). This review applies a simplified form of systematic literature review. The duplicability of a systematic review is still kept but the steps involved are reduced. For example, we designed a much more simple review protocol and removed steps such as backwards snowballing, which means checking references of all selected papers. However, we have checked references of some of the selected papers to keep in line with the systematic literature review methodology. Similarly, a step of asking the most prolific researchers about other studies that can be added to the set of selected papers is not carried out since there has been neither time nor access to any of the researchers in question. Instead, our supervisor has been the main source of feedback, especially in showing us the possibility of conducting a system literature review.
4 Result of the Systematic Literature Review

In the previous section, the research method and search strategy was explained to identify the most relevant primary studies and to extract the data for answering our research questions. In this section, the results of the systematic literature review are presented. First, we outline the sources and the years of publications. Then we examine the results of the primary studies in order to answer our stated questions.

The result is presented in the same order as in the process of the systematic literature review (Figure 6).

4.1 Identify Review Questions

Further review questions were identified in order to execute the systematic literature review. Kitchenham (2004) explains that it is crucial to have clear and precise research questions in place before starting a systematic literature review. Therefore, based on our research questions,

- How can we, by using systematic literature review, reach an understanding of what differentiates Green IS from Green IT?
- Given the current state of Green IS in academic research, what is the span of research within the field?
- To what extent are the different dimensions of sustainability studied?

we composed the following review questions to assist the literature review.

- What research has been conducted, and where and when was it published?
- What research questions have been asked and what were the findings?
- Which theoretical frameworks and theories have been employed?
- What is the role of IS in Green IS research?
- What Green IS concepts have been employed and how were they defined?
- Which dimensions of sustainability have been studied?

4.2 Review Protocol

In section 3.2.2, we highlighted the importance of creating a review protocol, which is a list of tasks to be performed for answering our overall and specific research questions.

In the making of the review protocol, we were in a process of designing the search strategy, which included defining the keywords and combinations of query strings used in the literature search. Moreover, we decided on data sources (see Table 2) where we performed the search.
Also, the inclusion and exclusion criteria as well as what kinds of data we were going to extract from the identified studies were finalised and added to the review protocol.

### 4.3 Search Strategy

The total number of articles after executing the query search strings was 69 (without duplicates). Table 3 shows the results from each of the data sources after we executed the search strategy. Then we read through the abstracts and removed the irrelevant articles.

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus</td>
<td>89</td>
</tr>
<tr>
<td>Emerald Insight</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>94</td>
</tr>
<tr>
<td>Total (without duplicates)</td>
<td>69</td>
</tr>
</tbody>
</table>

### 4.4 Assess against inclusion and exclusion criteria

After performing the search strategy, we assessed the results of the search strategy against the inclusion and exclusion criteria, followed by a further selection.

When we performed our search, we sorted the results by the number of citations. By doing this, the quality of the articles can be assured. At the same time, a few considerations were taken. As previously mentioned, Green IS is a fairly new area and thus there are few papers that exceed 100 in the citation index. New ideas and theories tend to appear more often in conferences yet conference proceedings usually have fewer citations. This is one of the important considerations when we selected the papers for further reading.

As mentioned in section 3.2.4, the citation index information was collected from both SCI Expanded and Scopus in order to ensure a higher coverage and maintain high reliability. This combination is proven to be valuable as Scopus has a wider collection of journals and conference proceedings while SCI has a longer history and is known to include notable journals.

As a result, we had 18 articles left to be included in this review. The list of all selected articles is shown in Table 4.
<table>
<thead>
<tr>
<th><strong>Author</strong></th>
<th><strong>Title</strong></th>
<th><strong>Source</strong></th>
<th><strong>Year</strong></th>
<th><strong>Citation Index</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengtsson, F. &amp; Ågerfalk, P.</td>
<td>Information technology as a change actant in sustainability innovation: Insights from Uppsala</td>
<td>Journal of Strategic Information Systems</td>
<td>2011</td>
<td>9</td>
</tr>
<tr>
<td>Butler, T.</td>
<td>Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS</td>
<td>Journal of Strategic Information Systems</td>
<td>2011</td>
<td>16</td>
</tr>
<tr>
<td>Chen, A., Boudreau, M. &amp; Watson, R.</td>
<td>Information systems and ecological sustainability</td>
<td>Journal of Systems and Information Technology</td>
<td>2008</td>
<td>N/A</td>
</tr>
<tr>
<td>Dao, V., Langella, I. &amp; Carbo, J.</td>
<td>From green to sustainability: Information Technology and an integrated sustainability framework</td>
<td>Journal of Strategic Information Systems</td>
<td>2011</td>
<td>17</td>
</tr>
<tr>
<td>Dedrick, J.</td>
<td>Green IS: Concepts and Issues for Information Systems Research</td>
<td>Communications of the Association for Information Systems</td>
<td>2010</td>
<td>N/A</td>
</tr>
<tr>
<td>Ijab, M., Molla, A., Kassahun, A. &amp; Teoh S.</td>
<td>Seeking the &quot;Green&quot; in &quot;Green IS&quot;: A spirit, practice and impact perspective</td>
<td>PACIS 2010 Proceedings</td>
<td>2010</td>
<td>N/A</td>
</tr>
<tr>
<td>Jenkin, T., Webster, J. &amp; McShane, L.</td>
<td>An agenda for ‘Green’ information technology and systems research</td>
<td>Information and Organization</td>
<td>2011a</td>
<td>22</td>
</tr>
<tr>
<td>Jenkin, T., Webster, J. &amp; McShane, L.</td>
<td>Green information technologies and systems: Employees' perceptions of organizational practices</td>
<td>Business and Society</td>
<td>2011b</td>
<td>4</td>
</tr>
<tr>
<td>Melville, N.</td>
<td>Information systems innovation for environmental sustainability</td>
<td>MIS Quarterly: Management Information Systems</td>
<td>2010</td>
<td>48</td>
</tr>
<tr>
<td>Molla, A.</td>
<td>Identifying IT sustainability performance drivers: Instrument development and validation</td>
<td>Information Systems Frontiers</td>
<td>2013</td>
<td>1</td>
</tr>
</tbody>
</table>
Now we are going to present the result of the data extraction. It is sorted under each review question.

### 4.5.1 What research has been conducted, and where and when was it published?

In total, 18 relevant studies were identified, of which 15 are journal articles and three are conference proceedings papers. A list of the selected journal and conference proceedings is shown in Table 4. The complete list of the selected articles can be found in Table 5 below.

**Table 5. List of journals and conferences with selected articles**

<table>
<thead>
<tr>
<th>Journal/Conference</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal of Strategic Information Systems</td>
<td>4</td>
</tr>
<tr>
<td>Journal of Systems and Information Technology</td>
<td>2</td>
</tr>
<tr>
<td>Information Systems Frontiers</td>
<td>2</td>
</tr>
<tr>
<td>IT Professional</td>
<td>2</td>
</tr>
<tr>
<td>Australasian Conference on Information Systems</td>
<td>2</td>
</tr>
<tr>
<td>Australasian Journal of Information Systems</td>
<td>1</td>
</tr>
<tr>
<td>Business and Society</td>
<td>1</td>
</tr>
<tr>
<td>Communications of the Association for Information Systems</td>
<td>1</td>
</tr>
<tr>
<td>Information and Organization</td>
<td>1</td>
</tr>
<tr>
<td>MIS Quarterly</td>
<td>1</td>
</tr>
<tr>
<td>PACIS</td>
<td>1</td>
</tr>
</tbody>
</table>

Amongst the 18 selected papers, the earliest one was published in Journal of Systems and Information Technology in year 2007. The earliest conference proceedings paper was published in ACIS 2008 Proceedings - 19th Australasian Conference on Information Systems in 2008. Figure 7 presents a number of publications per year, showing the number of publications has been increasing since Green IT was first introduced in 2007.
The number of journal publications peaked in 2011 when the Journal of Strategic Information Systems (JSIS) published a special edition on Green IT, figuring eight articles with focus on regulations, technologies, assessment and consequences (Berthon & Donnellan 2011).

As the search of this review has an end limit March 2014, there is no relevant study selected in 2014 yet. The results also revealed that one article (Jenkin et al., 2011) is from an environmental management journal (Business and Society), one from an organisational management journal (Information and Organization) and the rest from IS journals.

Table 5 shows the authors, their countries of locations and research institutions. It shows that researchers from Australia and the USA are most active in the topic of Green IS. In total, 7 scholars from Australia produced a total of 6 papers while 11 scholars wrote 6 papers from the USA.

**Table 6. Author affiliation details**

<table>
<thead>
<tr>
<th>Country</th>
<th>Research Institution</th>
<th>Authors and Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>RMIT University</td>
<td>Ijab, Molla, Kassahun &amp; Teoh 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ijab, Molla &amp; Cooper 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Molla 2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Molla 2013</td>
</tr>
<tr>
<td></td>
<td>University of West Sydney</td>
<td>Murugesan 2013</td>
</tr>
<tr>
<td></td>
<td>Edith Cowan West Sydney</td>
<td>Standing &amp; Jackson 2007</td>
</tr>
<tr>
<td>Ireland</td>
<td>Cork University College</td>
<td>Butler 2011</td>
</tr>
<tr>
<td>Sweden</td>
<td>Uppsala University</td>
<td>Bengtsson &amp; Agerfalk 2011</td>
</tr>
<tr>
<td>USA</td>
<td>University of Michigan</td>
<td>Melville 2010</td>
</tr>
<tr>
<td></td>
<td>University of New Mexico</td>
<td>Bose &amp; Luo 2011</td>
</tr>
<tr>
<td></td>
<td>University of Pennsylvania</td>
<td>Dao, Langella &amp; Carbo 2011</td>
</tr>
<tr>
<td></td>
<td>Syracuse University</td>
<td>Dedrick 2010</td>
</tr>
<tr>
<td></td>
<td>University of Georgia</td>
<td>Chen, Boudreau &amp; Watson 2008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chen, Watson, Boudreau &amp; Karahanna 2010</td>
</tr>
</tbody>
</table>
4.5.2 What research questions have been asked and what were the findings?

Based on our data extraction, we have extracted the research questions, if they are available as well as their purposes. The findings of the selected articles are also presented in Appendix. This table is in Appendix since it contains a large number of information that may claim plenty of space.

4.5.3 Which theoretical frameworks and theories have been employed?

Due to the multifaceted nature of Green IS, the research makes use of a wide range of theoretical frameworks and theories. Amongst the 18 selected articles, 10 frameworks and theories are identified (Refer to Table 7 for the full list). The most frequently used is institutional theory that three articles have used as a lens to study the factors that motivate organisations to adopt Green IT/S initiatives. Institutional theory is often used to examine why organisations take similar initiatives even with different starting points. It focuses on the procedure of how ideas and thinking become part of the accepted and internalised practices in organisations (Scott 1987).

With the use of institutional theory, Chen, Boudreau & Watson (2008) focus on two types of isomorphic pressures - mimetic and coercive pressures. In their study, a comparison between the role of mimetic and coercive pressures on Green IT initiatives is conducted. It found that coercive pressures such as regulations and legislations are the most effective in terms of promoting pollution prevention and sustainable development. While the mimetic mechanism is important, it drives organisation to adopt Green IS practices mostly due to the positive outcomes shown by other organisations’ Green IS practices. In particular, organisations tend to follow the others’ practices instead of taking the initiatives themselves first.

Chen et al. (2010) employ natural-resource-based view to classify different Green IT and Green IS initiatives. They categorised them into pollution prevention, product stewardship and sustainable development.

<table>
<thead>
<tr>
<th>Theoretical frameworks and theories</th>
<th>Number</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor Network Theory</td>
<td>1</td>
<td>Bengtsson &amp; Ågerfalk 2011</td>
</tr>
<tr>
<td>Balanced Scorecard</td>
<td>1</td>
<td>Molla 2013</td>
</tr>
</tbody>
</table>
Belief-action-outcome theory (BAO)  1  Melville 2010
Diffusion of innovation  1  Bose & Luo 2011
Green IT/S research framework  1  Jenkin et al. 2011b
Institutional Theory  3  Butler 2011; Chen et al. 2008; Chen et al. 2010
Natural-resource-based view  2  Chen et al. 2010; Ijab et al. 2011
Resource-based view (RBV)  1  Dao et al. 2011
Technology-organization-environment (TOE)  1  Bose & Luo 2011
Theory of Practice  1  Ijab et al. 2011
Process virtualization theory  1  Bose & Luo 2011
No specific theoretical frameworks/theories  7  Dedrick 2010; Ijab et al. 2010; Jenkin et al. 2011a; Molla 2008; Murugesan 2008; Standing & Jackson 2007; Unhelkar 2011

4.5.4 What is the role of IS in Green IS research?

As previously presented in section 2.3, the role of IS can be seen as a problem and/or a solution in the context of environmental sustainability, depending on the point of view of the scholars.

Table 8. The Role of IS

<table>
<thead>
<tr>
<th>Citation</th>
<th>Role of IS</th>
<th>IS as a solution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Problem</td>
<td>Solution</td>
</tr>
<tr>
<td>Bengtsson &amp; Ågerfalk 2011</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bose &amp; Luo 2011</td>
<td>X</td>
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<td>Butler 2011</td>
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<td>Chen et al. 2008</td>
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<tr>
<td>Chen et al. 2010</td>
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<td>X</td>
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<tr>
<td>Dao et al. 2011</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Dedrick 2010</td>
<td>X</td>
<td>(IT as a problem)</td>
</tr>
<tr>
<td>Ijab et al. 2010</td>
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<tr>
<td>Ijab et al. 2011</td>
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<td>X</td>
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<tr>
<td>Jenkin et al. 2011a</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Jenkin et al. 2011b</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Melville 2010</td>
<td>X</td>
<td>(IT as a problem)</td>
</tr>
</tbody>
</table>
How do the scholars of the articles see the role of IS in the context of environmental sustainability? All of them identify IS as a solution for improving the environmental issues though some of them also explain that IS can be a part of a problem for environmental degradation. When some consider IT is a source of carbon emission and as part of IS, it is applicable to propose that IS is part of the problem (Chen et al. 2010; Murugesan 2008; Standing & Jackson 2007; Ijab et al. 2010). For example, Chen et al. (2010) writes that IT and IS contribute to environmental issues as well as solution in different ways. Chen et al. (2010) differentiate IT and IS clearly and explains that there are big differences on the use of the concepts IT, IS and ICT. They (ibid.) state that IT is a group of devices/hardware that handle, store, transmit information while IS focus on the cooperation between people, processes, software and IT in order to support organisational goals.

Others consider IT itself to be a problem while IS is considered to be a solution (Melville 2010; Dedrick 2010). Amongst those who consider IS as a solution, Dedrick (2010) & Jenkin et al. (2010a) describe IS as enabler. According to Dedrick (2010), IS can be a solution by increasing production and energy efficiency whereas IT as in data centres is a problem that needs to be mitigated. Ijab et al. (2010) believe that IS is a contributor (promoter). Murugesan (2008) and Unhelkar (2011) consider IS acting as a promoter. Jenkin et al. (2011a) consider IS as a solution and an enabler, and explain that IT/S can be used to develop systems for measuring, tracking and reporting, which is considered an environmentally conscious/aware IS. Furthermore, the exploding use of IT and IS can be used as an enabler for reducing degrading impacts on the environment (ibid.)

The different roles of IS as a solution, an enabler and a transformative power are described in a positive sense by numerous researchers.

### 4.5.5 What Green IS concepts have been employed and how were they defined?

As shown in Table 9, there are a large variety of Green IS terms that have been used by different authors in their studies.
Table 9. Use of Green IS terms in selected articles

<table>
<thead>
<tr>
<th>Green IT</th>
<th>Green IS</th>
<th>Green ICT</th>
<th>Sustainable IT/IS/ICT</th>
<th>IS for eco-sustainability</th>
<th>Sustainable Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengtsson &amp; Ågerfalk 2011</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X (Sustainability innovation)</td>
<td></td>
</tr>
<tr>
<td>Bose &amp; Luo 2011</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Butler 2011</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Chen et al. 2008</td>
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<td>Chen et al. 2010</td>
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<tr>
<td>Dao et al. 2011</td>
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<tr>
<td>Dedrick 2010</td>
<td>X</td>
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<td></td>
</tr>
<tr>
<td>Ijab et al. 2010</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X (Sustainable IS)</td>
<td></td>
</tr>
<tr>
<td>Ijab et al. 2011</td>
<td>X</td>
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<tr>
<td>Jenkin et al. 2011a</td>
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<tr>
<td>Jenkin et al. 2011b</td>
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</tr>
<tr>
<td>Melville 2010</td>
<td>X</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Molla 2008</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molla 2013</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murugesan 2008</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ryoo &amp; Koo 2013</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Standing &amp; Jackson 2007</td>
<td></td>
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<td>X</td>
<td></td>
</tr>
<tr>
<td>Unhelkar 2011</td>
<td>X</td>
<td></td>
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</tr>
</tbody>
</table>

As mentioned in the question above, IT and IS are being used interchangeably. Therefore, there is no agreement whether IS or IT is just a problem or it can be a solution. This paradox extends into the use of terms such as Green IT, Green IS, Green ICT, Sustainable IT/IS/ICT, IS for environmental sustainability and etc. (See Table 9).

Most of the studies except two (Chen, Boudreau & Watson 2008; Standing & Jackson 2007) mention Green IT, which first appeared in academic journal in 2007. Hence, it has attracted attention for a longer period of time. It is not hard to understand why it is mentioned in numerous studies.

Many use both of the terms Green IT and Green IS in their articles (Butler 2011; Chen et al. 2010; Dedrick 2010; Molla 2013; Jenkin et al. 2011a; Jenkin et al. 2011b). Jenkin et al. (2010a) and Jenkin et al. (2010b) use a larger scope of the term Green IT/S. Other varieties, for example, Greening a business and Greenness of IS used by Ijab et al. (2010). Ijab et al. (2010) and Molla (2013) stress that even though Green IT and Green IS are interdependent on each other; their focuses and purposes differ from each other.

In the study by Jenkin et al. (2011b), it is demonstrated that the adaptation of Green IT/S is still in the early beginning stage. Can this be one of the reasons why there are such a large variety of definitions, for they do not know how to define a certain term, or what the concept should include? However, Dedrick (2010) argues that Green IS is simply a hype that will disappear when the next critical question surfaces.

While Murugesan (2010) discusses that organisations can meet this upcoming trend.
Jenkin et al. (2011a) stress that this trend could be a snowballing effect. The more commitments and motivations inputted, the better the effects in form of strategies and initiatives. Such engagement can lead to a further development in the concept of Green IS.

**Green IT**

Murugesan (2008), Murugesan (2010) and Dedrick (2010) state that the concept Green IT covers everything in IT and IS. Murugesan (2010) argues that IT, IS & ICT are covered in Green IT. In contrast, some differentiate them (Butler 2011; Chen et al. 2010; Dedrick 2010; Jenkin et al. 2011a; Jenkin et al. 2011b; Melville 2010). One such case is Dedrick (2010), who is very careful to point out that Green IS is a part of Green IT. He argues that Green IS helps Green IT with emission management as well as effective processes that enable emission reduction (ibid.).

Many use Green IT to cover both Green IT and Green IS. Is it possible use Green IT to cover everything within Green IT & IS? As Ijab et al. (2010) explain that since there are so many different concepts used to mean more or less the same things in the Green IS research, this makes it confusing and difficult to understand. They (ibid.) discuss the use of Green IT, Green IS, Green ICT, Green IT/IS and Sustainable in previous research. Likewise, Erek et al. (2009) conclude that if there is no consensus in the use of concepts, it creates unnecessary difficulties in communication and research.

According to Dedrick (2010) it is easier to apply measures in IT operation costs in order to reduce negative environmental impact. It can be data centres, equipment and processes that reduce the energy use within a product life cycle frame (Dedrick 2010; Jenkin et al. 2011a). Furthermore, there are claims that no organization would adapt Green IT if it is not for economic advantage such as IT cost reduction (Murugesan, 2008). In some cases (ibid.), tax reductions are offered if organisations employ a certain set of “Green” practices. Green IT should adopt a holistic approach, by Green use, green disposal, green design and green manufacturing, to achieve environmental sustainability (ibid.).

**Green IS**

Green IS is one of the key focuses in the literature search, hence there are plenty of articles that have special focus on Green IS. For example, Butler (2011) describes that an integrated IS can assist a whole supply chain to produce a sustainable product. Such IS is considered Green IS (ibid.) It is argued that Green IS would be a tool for other areas to become more sustainable, thus proposing a question: how Green is Green IS? (ibid.). However, the question was not answered in the study.

Standing & Jackson (2007) argues that IS can work towards better sustainability and support organisations as a whole instead of focusing only on IT operation. However, they point out that we need to see other connections/relations, especially between IS and economics. To achieve a broader purpose, questions about social and environmental impact have to be highlighted, and thereby we can start working towards/with sustainability (Standing & Jackson, 2007).
Meanwhile, Molla (2013) defines Green IS as the use of IS to improve eco-sustainability through automation, information and conversion of products, business processes, business relationships and practices.

Table 10 shows a selection of definitions and concepts of Green IT and Green IS found in the review articles.

**Table 10. Conceptualisation of Green IS**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Conceptualisation of Green IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler (2011, p.7, p.11)</td>
<td>Green IS may include existing IT-based platforms that have been transformed such as to support environmentally sustainable business processes</td>
</tr>
<tr>
<td></td>
<td>Green IS could be applied, for example, to monitor and report on GHG emissions; control and report on waste, toxic and hazardous materials use; manage energy-consuming facilities (e.g. transport and buildings management); help design greener products; and to redesign business processes across the enterprise so as to be environmentally sustainable</td>
</tr>
<tr>
<td></td>
<td>If Green IS are being employed by organisations to address problems of compliance with regulatory, normative, and cultural-cognitive obligations and social responsibilities caused by complex and equivocal information from the institutional environment, then such IS will need to support sense-making, decision making and knowledge creation in order to achieve environmental sustainability objectives.</td>
</tr>
<tr>
<td>Chen et al. (2010 p.25, 27)</td>
<td>Categorize organizational Green IS &amp; IT practices into three groups based on their different strategic orientations, i.e., pollution prevention, product stewardship, and sustainable development</td>
</tr>
<tr>
<td></td>
<td>Green IS &amp; IT refers to IS &amp; IT products (e.g., software that manages an organization’s overall emissions) and practices (e.g., disposal of IT equipment in an environmentally friendly way) that aim to achieve pollution prevention, product stewardship, or sustainable development.</td>
</tr>
<tr>
<td>Dedrick (2010 p.173)</td>
<td>“Green IS refers to the use of information systems to achieve environmental objectives.”</td>
</tr>
<tr>
<td>Ijab et al. (2010 p.1)</td>
<td>“Green IS can be identified by knowing the “what” to inscribe in IS to make it Green, the “where” to inscribe Green in IS, the “how” to inscribe Green in IS and the “when” to inscribe Green in IS.”</td>
</tr>
<tr>
<td>Ijab et al. (2011 p.5)</td>
<td>Green IS practices can be classified into three categories – Green IS practice with a focus on pollution prevention; Green IS practice with a focus on product stewardship, and Green IS practice with a focus on sustainable development</td>
</tr>
<tr>
<td></td>
<td>Green IS practices focusing on pollution prevention refer to the innovation and use of information systems (such as enterprise carbon and energy management systems) to reduce pollution generated by business operations. Green IS practices focusing on product stewardship refer to the innovation and use of IS (such as enterprise digital platforms and communication and collaboration systems) that enhance the environmental friendliness of upstream and downstream supply chains.</td>
</tr>
<tr>
<td>Jenkin et al (2010a p.18)</td>
<td>Green IT/S refers to information technology and system initiatives and programs that address environmental sustainability. ‘Green IS’, refers to the development and use of information systems to support or enable environmental sustainability initiatives and, thus, tends to have an indirect and positive impact.</td>
</tr>
</tbody>
</table>
Green IS initiatives tend to have an indirect impact, with a primary focus on designing and implementing systems to support environmental management processes.

We thus define IS for environmental sustainability as IS-enabled organizational practices and processes that improve environmental and economic performance.

Green IS refers to the use of information systems to improve eco-sustainability through automating, informing and transforming products, business processes, business relationships and practices.

“… the study and practice of designing, manufacturing, using and disposing of computer, servers and associated subsystems … efficiently and effectively with minimal or no impact on the environment.”

4.5.6 Which dimensions of sustainability have been studied?

Beside environmental/ ecological sustainability, other dimensions of sustainability are also used in the studies (See Table 11).

<table>
<thead>
<tr>
<th>Citation</th>
<th>Social</th>
<th>Economic</th>
<th>Environmental/ Ecological</th>
<th>CSR</th>
<th>TBL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengtsson &amp; Ågerfalk, 2011</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>Bose &amp; Luo, 2011</td>
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<tr>
<td>Butler, 2011</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Chen et al., 2008</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Chen et al., 2010</td>
<td></td>
<td></td>
<td></td>
<td>X(SBL)</td>
<td></td>
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<tr>
<td>Dao et al., 2011</td>
<td>X</td>
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<tr>
<td>Dedrick, 2010</td>
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<td>Ijab et al., 2011</td>
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<td>Ijab et al., 2010</td>
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<td>X</td>
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<tr>
<td>Jenkin et al., 2011a</td>
<td>X</td>
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<td>X</td>
<td></td>
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<tr>
<td>Jenkin et al., 2011b</td>
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<td></td>
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<td>X</td>
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<tr>
<td>Melville, 2010</td>
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<tr>
<td>Molla, 2008</td>
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<td>X</td>
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<tr>
<td>Molla, 2013</td>
<td>X</td>
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<td></td>
<td>X</td>
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<tr>
<td>Murugesan, 2008</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Ryoo &amp; Koo, 2013</td>
<td></td>
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<td>X</td>
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<tr>
<td>Standing &amp; Jackson, 2007</td>
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<tr>
<td>Unhelkar, 2011</td>
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</table>

Environmental sustainability

As Green IS mainly focuses on the environmental dimension of sustainability, it is not surprising that all the studies focus on it. The urgency of the climate and environmental issue prompt them to react with the powerful use of IS. For instance, Jenkin et al. (2011b) and Unhelkar (2011) focus on the environmental approach to sustainability. Environmental sustainability is about working towards protection of nature. The decisions organisations made have to minimize the negative impacts on the environment through the development of sustainable processes. It can also be achieved by efficient processes and products in order
to save energy (Unhelkar, 2011). At the same time, the article (ibid.) did not mention benefits of economic sustainability with energy efficiency.

Likewise, Chen et al. (2008) argue that ecological sustainability will be the most critical goal to work towards. They stress that nature has to be safeguarded against further degradation since the natural resources will not last forever. Once the oil is gone, it is gone. Cartwright & Craig (2006) emphasise that environmental unsustainability poses serious consequences for most of the world's population. Furthermore, Melville (2010) agrees that environmental sustainability is one of the greatest challenges. IS is expected to play a key role in reducing the negative environmental impacts through practices such as business process re-engineering and energy monitoring (Jenkin et al. 2011). Likewise, Molla (2013) states that environmental sustainability should be seen as a strategy with an enormous potential and it should not be used for green washing purpose only.

The factors which influence organisations to undertake Green IS initiatives/environmental sustainability are explored in numerous studies. Motivations for environmental sustainability can be divided into internal and external motivations. Jenkin et al. (2011a) explain that the internal motivation comes from the organization itself while the external motivations are regulatory, social & cultural, environmental and technological. The motivating forces can also be normative, cultural-cognitive or strategic (Butler 2011).

Butler (2011) connect environmental sustainability with green IT in "the concept of environmentally sustainable or Green IT..." (Butler 2011, p.7). He argues that government (regulatory force) has been acting as a driving force for leveraging environmental sustainability and enforcing environmental policy.

**Economic sustainability**

Though economic gains is a common theme when it comes to the potential cost-saving benefits brought by Green IT practices, there are a those who choose not to mention it explicitly (Jenkin et al. 2011; Unhelkar 2011). Neither Molla (2008) brings up the economic sustainability, but he indicates by "... the role of IT in supporting a business overall sustainability initiatives." (Molla 2008, p.662).

**Economic and environmental sustainability**

Dedrick (2010), Murugesan (2008) and Melville (2010) bring up the economic sustainability and environmental sustainability together. There is a clear correlation between these two factors, emissions and cost. By making data centres, servers and systems more energy efficient, organisations can thus enjoy the cost-saving benefits (Dedrick 2010).

This manifests itself directly on the economic sustainability, but also the environmental sustainability. As an increasing number of organisations implement measures to control and report the energy consumption and carbon emission levels, it becomes clearer to understand the connection between energy-saving practices and their benefits.
Environmental, social and economic sustainability
Several articles mention all three aspects of sustainability – social, environmental/ecological and economic sustainability (Bengtsson & Ågerfalk 2011; Bose & Luo 2011; Butler 2011; Chen, Boudreau & Watson 2008; Molla 2013; Murugesan 2008; Smith & Sharicz 2011; Standing & Jackson 2007; Osch & Avital 2011; Dao, Langella & Carbo 2011).

Chen et al. (2008) and Dao, Langella & Carbo (2011) explain that organisations have to work with the three aspects of sustainability in order to create a long-term sustainable organisation. A holistic approach with considerations for all three factors of sustainability is needed to advance the potentials of Green IS.

Nevertheless, Molla (2013) illustrates that the work on sustainability has two directions, responsive and strategic. Organizations must use a holistic approach to the work of environmental sustainability (ibid.).

Triple Bottom Line (TBL)
Butler (2011) defines TBL as a need for organisations to take responsibility towards sustainability through policies and measures. With the adoption of TBL, it creates a holistic approach, in which all three sustainability aspects are given space to work with and balance out. Some combine the three aspects of sustainability with the concept of TBL, providing a holistic view on the work of sustainability (Bengtsson & Ågerfalk 2011; Butler 2011; Chen, Boudreau & Watson 2008; Dao, Langella & Carbo 2011; Standing & Jackson 2007). Bengtsson & Ågerfalk (2011) describe TBL as a tool to “capture the criteria for measuring success in the areas of economic, environmental and social goals of organisations”.

CSR
Amongst the 18 selected articles, six of them mention CSR. According to Jenkin et al. (2011b), CSR is a demand from the stakeholders. They define CSR as “company activities - voluntary by definition - demonstrating the inclusion of social and environmental concerns in business operations and in interactions with stakeholders” (Jenkin et al. 2011b, p.267).

In their study, Jenkin et al. (2011b) found that employees have begun to understand the connection between IT/S and CSR and that it can contribute to the environmental sustainability. However, the impact of CSR in relation to the sustainability has not been measured. Butler (2011), Dao et al (2011) and Standing & Jackson (2007) also use all three dimensions of sustainability together with CSR in their studies.

We can conclude that CSR is not a dominant aspect in Green IS research since it is more of an organisational point of view, meaning that it is often the organisations themselves who define and weigh the significance of CSR internally.

Molla (2013) argues that the difficulties of adapting sustainability are not understanding the concept, but it is about shrinking budgets and doing more with less. Molla (2013) states that there are studies, which discuss that the implementation of Green IT/S initiatives would give a better result, both economic and environmental. Would it be driving force for Green IS initiatives if there were studies that could demonstrate positive results both economically and
environmentally? With time, the concept of Green IT/S will develop to a mature level where the positive results brought by it can be measured (Cooper & Molla 2013).

**Sustainability framework**

Besides the dimensions of sustainability, there are a few articles who highlight the need to develop a framework for measuring IT-enabled processes for environmental sustainability. Molla (2013) proposes that there is a need for a common framework, which serves as a base for comparison and evaluation of the impacts of Green IS practices.

Likewise, Standing & Jackson (2007) identify that the COBIT framework has a more economical approach and has a great potential to evolve to include other sustainability principles. A framework comprised of all three types of sustainability may provide guidance in the process of sustainability (ibid.).

However, the development of a common framework has been slow. Combining a well-established framework such as COBIT with the sustainability aspects can accelerate the development of Green IT/IS. Especially when the government organisations have already established environmental policy (Jenkin et al. 2011a).
5 Analysis of the Systematic Literature Review

The following chapter analyses the result of the systematic literature review with the theoretical baseline presented in Section 2. As presented in the previous chapter, the result obtained by extracting data for answering the review questions gave a good overview of the current Green IS research. The aim of this chapter is to serve as one of the bases for the discussion and conclusions in the following chapter.

The interchangeable use of the IT/IS is widespread

As seen in the result of the systematic literature review, it is clear that there is still no consensus in the use of IT and IS. Consequently, when another diffuse variable added – environmental sustainability, the scholars as well as the practitioners have difficulties in settling into a common term/construct.

Therefore, Green IT and Green IS are used interchangeably in the similar way. As shown in the result (see Table 9), many use both Green IT and Green IS but there are those who merge two together and use Green IT/S instead. There are also cases in which Green IT covers everything, including Green IS/ICT. On the contrary, some state that Green IS is a part of Green IT by offering a system that measures carbon and energy emission, as well as by reducing the emission with more effective processes enabled by Green IS. However, some point out that there are distinct differences between those concepts and thus differentiate them from each other.

Amongst those that distinguish IT and IS, IT are devices that handle, store and transmit information while IS is a cooperation between people, processes enabled by software and IT, which support organisational goals (Melville 2010). Many believe that Green IT and Green IS are independent so that their focuses and purposes are different (Melville 2010; Bose & Luo 2011).

There are a large variety of concepts used in the research of Green IS, which may cause some confusion and difficulty to understand. Furthermore, IS is considered to be one of the most important tools for organisations’ sustainability yet it is not fully utilised (Melville 2010). Can the development of IS for environmental sustainability take off even though there is a lack of common "language"? As demonstrated in the result, the adaptation of Green IT/IS is in the beginning stage, which may explain why there is no consensus in the concepts and definitions.

The paradox of the role played by IS

The diverse view of what role IS should play for leveraging environmental sustainability prevails. Overall, IS has a positive role for environmental sustainability. It manifests into different roles – an enabler, a promoter and a transformative power.
An enabler and a solution are not the same but they are closely related. An enabler can be a solution. IS seems to play different roles in different contexts, from an enabler, a promoter, a contributor and ultimately a transformative force. This can be considered a kind of maturity ladder, which indicate the role of IS and how it is perceived in organisations. Furthermore, as we consider IS as an essential tool to transform business processes, IS should not be seen as a problem to sustainability. On the contrary, it should be regarded as a powerful solution/enabler to present day environmental issues.

Require theories and theoretical frameworks from different areas in order to study Green IS

Analysis of the literature highlights the limited focus and scope in the use of theories and conceptual frameworks (see Table 7). For example, institutional theories have been extensively used in analysing the factors that drive organisations to adopt Green IT and Green IS initiatives. The complexities of Green IS and what it can do require a richer and cross-disciplinary framework for fostering better understanding.

Economic viability before environmental sustainability or all together?

In the theoretical framework and the result of systematic literature review, it is shown that many organisations believe that having economic viability is a prerequisite for taking efforts for maintaining environmental sustainability for what they do.

However, it can be argued that the reverse priority should be considered, meaning that environmental sustainability is a vital prerequisite for economic and social sustainability (Goodland 1995). Without a sustainable environment, there would not be any renewable or non-renewable energy for production. When organisations cannot produce to make profit, then economic viability cannot be achieved.

This suggests that keeping the environment sustainable is fundamental for a sustainable business and society. Any business activities for profits rely on the resources provided by the environment. The emphasis on the balance between the environment, the people and their activities is necessary for a sustainable world in the future. In other word, the prevalent mindset of being economically viable in order to work towards environmental sustainability is probably not sustainable in the long run. A holistic view of sustainability is proposed to secure the future for further generations (Bengtsson & Ågerfalk 2011; Osch & Avital 2011).

Shift to sustainable innovation

In our review on the different dimensions of sustainability, even though the green in Green IS focuses mainly on the environmental aspect, it appears that quite a few studies cover two or more aspects of sustainability.

In order to have a more holistic view of sustainable values augmented by the use of IS in organisations, some researchers have created a construct Sustainable Innovation (Thatchenkery, Avital & Cooperrider 2010; Osch & Avital 2011). Sustainable innovation is defined as “designing and implementing sustainable organisational processes and practice that
generate social, environmental, and economic worth for all stakeholders involved” (Thatchenkery, Avital & Cooperrider 2010). In other words, it covers the innovation initiatives that target at a sustainability goal.

The terms Green IT and Green IS have been criticised to focus only on the environmental aspect of sustainable development, missing the opportunities to enable a sustainable organisational process transformation in economic, social as well as environmental aspects (ibid.). Osch & Avital (2011) argue that Green IT/IS is mainly concerned with cost reduction, neglecting the value-added potentials of sustainable innovations.

As the sustainability issue has to be primarily concerned with humans and their actions, placing a focus on only one aspect of it is not suffice for studying the intertwining relationship between IS and human activities. By focusing on a single line realm of sustainability, there is a possibility that a balanced and holistic approach to address the challenges to environmental sustainability is overlooked.

However, it is possible that before the ambiguity of Green IT and Green IS is resolved, we have already moved to a broader area such as sustainable innovation. As long as the underlying environmental issues lying underneath persist, the vital role of IS is still required, regardless of changing titles over time.
6 Conclusions & Discussion

The purpose of this study is to present the current state of Green IS research with an emphasis on the differentiation between Green IS and Green IT. The intention of this chapter is to conclude the systematic literature review, and summarise and discuss the stated research questions.

In the introduction we proposed our overall research question:

*How can we, by using systematic literature review, reach an understanding of what differentiates Green IS from Green IT?*

In order to study the overall research question specifically, we also posed two sub-questions to guide us through the study.

- *Given the current state of Green IS in academic research, what is the span of research within the field?*
- *To what extent are the different dimensions of sustainability studied?*

This study examines the status of IS for environmental sustainability research. We, methodologically, conducted a systematic literature review on journal papers and conference articles on Green IS within a timespan from year 2007 to 2014. Based on this literature review, this study presents an overview of the current state in the Green IS field.

From the result and analysis we learnt that there is a large variety of definitions of the concept Green IS. As many scholars and practitioners use the terms IT and IS interchangeably, Green IT and IS are thus used in the same manner, resulting in deeper confusion on what Green IT and Green IS actually are. This diffuse idea remains to be an obstacle in further development of Green IS since there is no common language for communications within academia as well as between academia, government organisations and businesses.

For instance, Molla (2008) uses Green IT to cover an umbrella of Green IT practices and Green IS initiatives. He (ibid. p.662) exemplifies adoption of Green IT practices with adoption of environment and energy management systems and video-conferencing, which belong to the supportive and transformative nature of Green IS. At the same time, Molla (ibid.) considers Green IT as practices in reducing IT waste by recycling and responsible disposing of IT products. This falls into the cost-saving benefits of Green IT.

We can thus conclude that such a variety of definitions may be due to the nascent stage of this research area, prompting the IS researchers and practitioners to create their own interpretations of what the terms mean and contain.

Besides the traditional IS theories and frameworks, for instance, institutional theory and diffusion of innovation, scholars have begun to look beyond and draw from theories from
other areas to study the multifaceted and complex nature of Green IS. For example, Elliot (2011) conducted a comprehensive study to develop a trans-disciplinary framework for IT-enabled business transformation for leveraging environmental sustainability. Such a framework was deemed necessary since the complexities of Green IS require a richer and cross-disciplinary framework for fostering better understanding.

When it comes to dimensions of sustainability, it is indicated by both the result and analysis that an increasing number of studies focus on more than one dimension. Numerous studies argue that all three dimensions of sustainability must be taken into consideration in order to maintain a long-term sustainable business and society (Chen, Boudreau & Watson 2008; Dao, Langella & Carbo 2011).

It is likely that in the near future many organisations will adopt all three dimensions of sustainability - social, economic and environmental - in order to achieve a more holistic approach to meet future needs (Bengtsson & Ågerfalk 2011).

In the analysis it became clear that a single focus on environmental sustainability might not suffice when it comes to study the relationship between sustainability and IS. A viewpoint shared by numerous studies is that the transformative power of IS can only be leveraged through wider lens of all realms of sustainability. According to Bengtsson & Ågerfalk (2011, p.96), sustainable innovation refers to "innovation explicitly directed at a sustainability goal". It is about creating social, economic and environmental value for all the stakeholders (Osch & Avital 2011). In order to apply an innovative sustainable approach, a change of values is required to reform a whole new culture of generating a sustainable world for the people, the society and the environment (ibid.).

An organisation needs to have a common understanding of what the term Green IS means or the organisation will be unable to implement strategies in a holistic manner. This means that directives on implementing green strategies need to have support in the top levels of the organisation, and the leadership of the organisation needs to be engaged in the implementation of such strategies. However, many of them still focus on the cost-saving benefits brought by energy-effective IT infrastructure (Bengtsson & Ågerfalk 2011).

IS has played an important role in transforming the society and the businesses in the last few decades. Though some argue that Green IS can simply be a fad (Dedrick 2010), we conclude it is here to stay. IS can be a true transformative force in addressing environmental issues as it has been in cost-cutting activities for many organisations. Environmental sustainability is one of the biggest problems we face in the coming generations. It requires the transformative power of IS and a mindset shift from an economic viewpoint to advance the role of IS for sustainability.

Though there is no consensus in the definitions of Green IT and Green IS amongst the academic papers studied, one thing they all agree on is that we need to make changes in order to offer a sustainable world for future generations and IS plays a crucial role in the
development of sustainability in both research and practice. IS should be an active agent in pursuing an overall sustainability for generations to come.

6.1 Implications for research and practice

The aim of this study was to gain a deeper understanding of what differentiate Green IT from Green IS and the status of Green IS research. By using systematic literature review, we identified 18 papers and extracted data for answering our stated questions. A large variety of IS concepts were identified, presenting little consensus of Green IS concepts and content. However we conclude that IS can play a pivotal role in development of environmental sustainability. There is also a noticeable call from IS academics that a holistic view of sustainability is required to make IS a truly transformative and impactful tool. This study augmented the importance of Green IS as a research topic in the field of IS.

In practice, a common understanding of what the terms Green IT and Green IS mean is recommended for undertaking any green initiatives. Organisations need to develop their own view of sustainability. The study can provide information on which terms are appropriate to use and what the terms mean. Since many concepts for Green IS are somewhat diffuse, this may give insight into the current trend and development of Green IS research. To some extent, this study contributed to practice of how the concepts were conceptualised and abstracted within Green IS research. Practitioners could use the tables presented as a source of reference when they plan to implement IS for environmental sustainability practices.

6.2 Future research and limitations

This study has to be considered with limitations in mind. Although there were 69 identified articles related to Green IS after the literature search, this study necessarily drew data from 18 of them due to the limited timeframe for conducting a Bachelor’s degree thesis. This limitation poses a potential reason for further research with a wider base of materials. In order to improve the validity of the result, a larger number of articles are needed.

Another limitation was to focus on the academic field of Green IS. Given the importance of practitioners on realising research work into social activities, it is therefore crucial to study how they perceive and manifest the ideas and practices of Green IS. Thus, future research can focus on the impacts of implementation of Green IS strategies and practices at an organisation level. Specifically, the relationship between the level of understanding of Green IS and the impacts of Green IS practices. Future research can examine how a common understanding of Green IS strategies in an organisation affects the outcomes and impacts of Green IS implementation.

Despite these limitations, this study may give some insight into the current state of Green IS research.
References


## Appendix

### Table 12. Research Questions and Findings of the Paper Reviewed

<table>
<thead>
<tr>
<th>Authors/year</th>
<th>Research questions/Purpose</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengtsson &amp; Ågerfalk 2011</td>
<td>How can IT serve as a change actant in sustainability innovation and what is the nature of its relation to other human and non-human actants?</td>
<td>The study suggests that there does not have to be much resistance to sustainability issues at the non-committal level in their study. They indicate that the resistances encountered appear mainly at an organizational level, where required changes are not supported by existing routines and the organizational structure that enforces them. Further they imply that implementing a successfully sustainability initiative with IT-based reporting and analysis requires a thorough review of organizational routines and standards to find solutions that can enrol all affected stakeholders.</td>
</tr>
<tr>
<td>Bose, Luo 2011</td>
<td>N/A</td>
<td>Contribute to research and practice, by offering an implication for Green IT literature and also provides a prescriptive guidelines for Green IT practices. Propose a theoretical framework to help understand business and IT phenomena that cannot be explained by existing theories in the IS literature. They also envisioned two additional generations of Green IT diffusion, and explicitly compared different pathways of Green IT migration through virtualization processes.</td>
</tr>
<tr>
<td>Butler 2011</td>
<td>1. What features and functions of Green IS are required to support: (i) sense-making; (ii) decision making; and (iii) knowledge sharing/creating activities in response to signals from the institutional environment? 2. How are the organisations studied using Green IS to support such activities?</td>
<td>Their findings support their study’s theoretical proposition that IT manufacturers require Green IS with advanced sense-making, decision making and knowledge sharing and creating features. All to react adequately to regulative, normative and cultural-cognitive forces/signals from the institutional environment.</td>
</tr>
<tr>
<td>Chen et al. 2008</td>
<td>How can IS help organizations achieve ecological sustainability?</td>
<td>Their findings contribute to the practice through identifying how IS could be deployed to be of use in eco-friendly operations.</td>
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<tr>
<td>Chen, Watson, Boudreau &amp; Karahanna 2010</td>
<td>How institutional pressures affect the adoption of green IS &amp; IT</td>
<td>First, it represents one of the few studies focusing on the role played by IS &amp; IT in green practices. They identify three types of IS &amp; IT-based green practices. Also they make an important distinction between IS and IT in driving ecological sustainability. Their research contributes to the literature of institutional theory by examining the interaction between institutional forces. This study also</td>
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provides empirical support for the complementary effects between mimetic and coercive pressures in driving the adoption of IS & IT-based product stewardship by organizations. They have introduced the idea of a new IS subfield, Energy Informatics, to focus on using IS & IT to improve energy efficiency.

<table>
<thead>
<tr>
<th>Dao, Langella &amp; Carbo 2011</th>
<th>What is the role of IT resources and their integration with human and supply chain resources in helping firms develop sustainability capabilities that help firms deliver sustainable values and gain sustained competitive advantage?</th>
<th>They show us that the development of sustainability capabilities requires a holistic approach. By showing that the integrated sustainability framework, focusing on developing sustainability capabilities will not only serve the environment and people. It can also help the organisation to generate value that could enhance profitability and gain sustained competitive advantage.</th>
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<tr>
<td>Dedrick 2010</td>
<td>1. Frame and define the issue 2. Analyse existing academic research as well as other data and reports 3. Present a new model of the impacts of IT on carbon productivity in the economy 4. Propose a set of issues and questions that might serve as an initial agenda for academic research on Green IS.</td>
<td>They implies that IS can influence carbon productivity and, hence, the ability to sustain economic growth while reducing GHG emissions. And also that the impacts of both Green IT and Green IS must be taken into consideration in a conceptual framework.</td>
</tr>
<tr>
<td>Ijab, Molla, Cooper 2011</td>
<td>How Green IS practices emerge and become recurrent in organisations</td>
<td>Unified Communication and Collaboration (UCC) system enables better way to communicate, to reduce carbon emission. Sustainable Document and Application Management (SDAM) system can give the business better workflows, by e-forms.</td>
</tr>
<tr>
<td>Ijab, Molla, Kassahun, Teo 2010</td>
<td>The aim of this paper is to address this lack of clarity surrounding the “Greenness” and “IS” in a Green IS</td>
<td>Proposed a conceptualisation of Green IS and identified six typologies of Green IS, which will facilitate researchers’ for further research.</td>
</tr>
<tr>
<td>Jenkin, Webster &amp; McShane 2011a</td>
<td>We develop a multi-level research framework to guide future research.</td>
<td>Encouraged empirical research on Green IT/S. The framework presented will motivate further research. They found four components – motivating forces, environmental initiatives (Green IT/S strategies and Green IT/S), environmental orientation, and environmental impacts – those provide a context for more fully examining this critical topic for both organizations and the planet. They believe that their propositions represent a valuable first step towards understanding how to overcome the challenges associated with implementing Green IT/S</td>
</tr>
<tr>
<td>Jenkin, Webster &amp; McShane 2011</td>
<td>1. To what extent do employees report IT/S-related practices as part of their organizations’ environmental practices?</td>
<td>Demonstrate that organizations are still in the early development of understanding and adoption of</td>
</tr>
<tr>
<td>Authors</td>
<td>Year</td>
<td>Findings/Excerpts</td>
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<tr>
<td>Melville 2010</td>
<td>N/A</td>
<td>Show how information systems influence beliefs and affect actions concerning sustainability, as well as the association between IS and economic and environmental outcomes. IS are an important but inadequately understood weapon in the arsenal of organizations in their quest for environmental sustainability.</td>
</tr>
<tr>
<td>Molla 2008</td>
<td>This paper proposes such a model called the Green IT Adoption Model (GITAM). The model defines Green IT from four distinct but interrelated perspectives.</td>
<td></td>
</tr>
<tr>
<td>Molla 2013</td>
<td>The purpose of the study summarized in this paper is to develop an eco-sustainability IT performance measurement system for firms in the IT industry.</td>
<td></td>
</tr>
</tbody>
</table>
| Murugesan 2008  | 1. What are the key environmental impacts arising from IT?  
2. What are the major environmental IT issues that we must address?  
3. How can we make our IT infrastructure, products, services, operations, applications, and practices environmentally sound?  
4. What are the regulations or standards with which we need to comply?  
5. How can IT assist businesses and society at large in their efforts to improve our environmental sustainability? | They indicate that IT is part of the environmental problem, but also that it can be part of the solution. That Greening IT is and will continue to be a necessity, not an option. Green IT is all about the economic, as well as an environmental, imperative. That’s in the future IT industry had to deal with the infrastructure requirements and the environmental impact of IT and its use. |
| Ryoo & Koo 2013 | 1. How green practices-IS alignment affects both green practices coordination and a firm’s environmental performance  
2. How green practices coordination along with other business functions affects a firm’s environmental performance. | They support that environmental performance influences economic performance. And that Green practices-IS alignment positively affects the outcomes, as environmental performance via green practices-manufacturing coordination and green practices-marketing coordination. |
| Standing & Jackson 2007 | N/A | They indicate that the COBIT model can be used to ascertain how an organisation rates in terms of accomplished sustainability processes. |
| Unhelkar 2011 | Predict current and future trends for this growing field | They propose that green IT initiatives are provide value to the business by enabling carbon-efficient processes, systems, technologies, and work practices. Business needs a holistic business strategy to align with their goals. |
Högskolan i Borås är en modern högskola mitt i city. Vi bedriver utbildningar inom ekonomi och informatik, biblioteks- och informationsvetenskap, mode och textil, beteendevetenskap och lärarutbildning, teknik samt vårdvetenskap.

På institutionen Handels- och IT-högskolan (HIT) har vi tagit fasta på studenternas framtida behov. Därför har vi skapat utbildningar där anställningsbarhet är ett nyckelord. Ämnesintegration, helhet och sammanhang är andra viktiga begrepp. På institutionen råder en närhet, såväl mellan studenter och lärare som mellan företag och utbildning.

Våra ekonomiutbildningar ger studenterna möjlighet att lära sig mer om olika företag och förvaltningar och hur styrning och organisering av dessa verksamheter sker. De får även lära sig om samhällsutveckling och om organisationers anpassning till omvärlden. De får möjlighet att förbättra sin förmåga att analysera, utveckla och styra verksamheter, oavsett om de vill ägna sig åt revision, administration eller marknadsföring. Bland våra IT-utbildningar finns alltid något för dem som vill designa framtidens IT-baserade kommunikationslösningar, som vill analysera behov av och krav på organisationers information för att designa deras innehållsstrukturer, bedriva integrerad IT- och affärsutveckling, utveckla sin förmåga att analysera och designa verksamheter eller inrika sig mot programmering och utveckling för god IT-användning i företag och organisationer.

Forskningsverksamheter vid institutionen är såväl professions- som design- och utvecklingsinriktad. Den övergripande forskningsprofilen för institutionen är handels- och tjänsteutveckling i vilken kunskaper och kompetenser inom såväl informatik som företagsekonomi utgör viktiga grundstenar. Forskningen är välrenommerad och fokuserar på inriktningarna affärsdesign och Co-design. Forskningen är också professionsorienterad, vilket bland annat tar sig uttryck i att forskningen i många fall bedrivs på aktionsforskningsbaserade grunder med företag och offentliga organisationer på lokal, nationell och internationell arena. Forskningens design och professionsinriktning manifesteras också i InnovationLab, som är institutionens och Högskolans enhet för forskningsstödjande systemutveckling.