

Green IT/IS Adoption within Organizations: A Systematic Literature Review and Research Agenda

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Abstract

Advances in technology have affected all sectors of the economy and environments of countries around the globe. Research studies of the relationship between environmental sustainability, information technology (IT), and information systems (IS) under the terms of Green IT and Green IS have grown exponentially in the IS research community in the past seven years. This paper provides a systematic academic literature review of the organization-level adoption of Green IT/IS to understand and summarize the existing studies related to the field with the aim of understating better the research field, categorizing the studies and identifying some research opportunities and gaps for future research. To provide a robust study, we have applied the upper echelon theory (UET) to formulate potential research questions for future researchers.

Keywords: Systematic literature review, Green IT/IS, Upper echelon theory, Environment, Sustainability, Adoption

1. Introduction

As advances in technology for the environment have occurred, there have been increasing concerns regarding environmental sustainability issues (Thomas et al., 2015, Nuss, 2015). Moreover, organizations and businesses are under overwhelming pressure from their shareholders and legislatives to improve their environmental sustainability activities (Melville, 2010, Butler, 2011a, Murugesan, 2008, Zheng, 2014, Frehe, 2015). Gärling et al. (2003) listed the environmental issues that organizations face as: (1) air pollution (outdoor and indoor), (2) solid waste disposal, (3) topsoil erosion, (4) ozone layer depletion, (5) population growth, (6) marine and fresh water pollution, (7) toxic waste accumulation and disposal, (8) reduction in biodiversity, (9) wetlands destruction, (10) deforestation, and (11) climate modification. This concern regarding the environment and climate by corporations is creating an impetus and ever increasing momentum, which sometimes is referred to as corporate ecological responsiveness (CER). Based on Bansal and Roth (2000), CER is defined as “a set of corporate initiatives aimed at mitigating a firm’s impact on the natural environment”, in which these initiatives can include changes to the firm’s products, processes, and

policies such as reducing energy consumption and waste generation, using ecological sustainable resources, and implementing an environmental management system.

Information technologies (IT) and information systems (IS) could be considered to be two CER initiatives of a firm’s response towards environmental sustainability. Based on a report in 2007, information and communication technologies (ICT) are responsible for 2% of global greenhouse gas (GHG) emission, which is equal to global aviation industry (Webb, 2008). Researchers have framed the impacts of IT on the environment as first, second, and third-order effects (Hilty et al., 2006, Köhler and Erdmann, 2004): (1) first-order effects are direct impacts from IT hardware during the product lifecycle, including production, use and disposal of computer equipment. This perspective considers IT as part of the problem (Molla and Abareshi, 2012, Dextrick, 2010). These effects are similar to the scope of Green IT. Therefore, making IT products, use, and disposal more environmental friendly and greener is referred to as Green IT (Dextrick, 2010, Molla and Abareshi, 2012, Ryoo and Koo, 2013, Gholami et al., 2013); (2) second-order effects are the effects of ICTs on other processes such as transportation or industrial production, influencing their environmental impacts. This

is similar to Green IS; and (3) third-order effects are longer term and more dynamic. They occur when widespread use of ICTs leads to changes in lifestyles and economic structures. Third-order effects may be seen in specific cases, such as telecommuting or the growth of home-based businesses built on e-commerce platforms such as eBay or Amazon. Overall, Green IT aims to reduce the 2% global emission from ICT, while Green IS focuses on reducing the remaining 98% by employing innovative IT and IS in business processes, which is estimated at approximately 7.8 Gt CO₂ saving in 2020 that equals to 15% cut emission and £600 billion of cost saving (Webb, 2008). Although, Green IT and Green IS are interrelated concepts, they do have their own specific focus and purposes.

Recognizing that Green IT and IS are important for the environment and that research in the area is still emerging, the aim of this research study is: (1) To identify the studies investigating the adoption of Green IT/IS in the academic literature, (2) To identify the trends of Green IT/IS adoption research theoretical frameworks, research methodologies, and investigated regions, and (3) To propose research agendas based on the reviewed literature for researchers interested in investigating Green IT/IS adoption.

To inform readers, this paper is organized as follows. Section 2 introduces the method applied for this systematic

review. The evolution of the Green IT and Green IS research areas are presented in Section 3. Section 4 provides the results of the review. A discussion of the findings together with the research agenda are provided in Section 5. Section 6 finally states the conclusion of the study.

2. Method

To identify studies of importance to the Green IS/IT issues and for trend identification, a systematic literature review (SLR) approach was applied to this study. An SLR aims to present and evaluate the literature related to the research topic by utilizing a thorough and auditable methodology. For this study, a methodology (see Figure 1) proposed by Kitchenham (2004) is applied. The two primary objectives of the literature review are: to identify, classify, and summarize existing research on the selected topic for this research; and to identify areas and opportunities for future research. Based on Kitchenham (2004), accomplishing an SLR involves several discrete activities that are categorized into three main phases: (1) planning the review, (2) conducting the review, and (3) reporting the review.

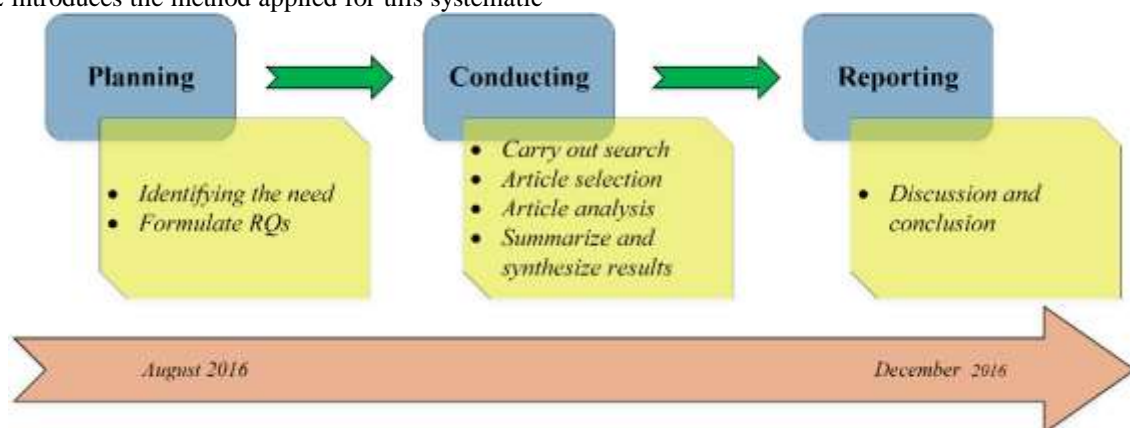


Fig. 1. Phases of SLR adapted from Kitchenham (2004)

The purpose of the planning phase is to plan on how to conduct an SLR for the targeted research topic. This phase includes two activities, which are to identify the need for an SLR, and formulating review research questions. Following the planning phase that includes identifying the motivation for conducting SLR in the topic and defining the review research questions, the next step involves conducting a review. When conducting the review, the pursued activities include a search to identify the primary studies, selecting appropriate articles, analyzing the selected studies, followed by a summary and synthesis of the results. Finally, the results of the SLR are discussed in phase three that is the final stage of the SLR. Fig. 1 depicts the activities of each phase.

3. Phase 1: Planning the SLR

3.1 Identifying the need for a systematic literature review

The concept of environmental sustainability is grounded in the theory of a Natural-Resource-Based View (Hart, 1995); where it is asserted that to enhance the environmental sustainability performance, three main objectives have to be considered: (1) pollution prevention, (2) product stewardship, and (3) sustainable development. To achieve these three goals IT and IS are of particular significance (Melville, 2010, Watson et al., 2010, Elliot, 2011). As previously explained, the effects of ICT on the environment (the negative and positive effects) are discussed by the IS community under the terms of Green IT (Green for IT) and Green IS (IT for Green). As a consequence of these newly defined topics in the IS community, there are a growing number of studies in the

empirical and theoretical research. Due to the increasing numbers of studies, it is pertinent to apply a systematic approach to assess and aggregate the research outcomes so that a balanced and objective summary of research evidence is obtained. This allows an understanding of the status quo of the research topic and also to identify the research opportunities for further research that constitutes parts of this study's objectives respectively.

3.2 Formulating the Review Research Questions

The research questions specifically addressed by this SLR are as follows:

How did Green IT and Green IS evolved?

By determining this question, the evolution of Green IT and Green IS is explained, along with the relationship between Green IS and IT with sustainability and environmental sustainability.

What are the primary studies on Green IT and Green IS?

This research question understands the key subjects that have been dealt with by these topics and using a count of publications, records all the answered key research questions.

What is the status quo of the organizational Green IT and Green IS adoption studies?

By answering this question, all the publications containing theoretical frameworks that are utilized for Green IT and Green IS adoption studies within organizations are analyzed. This identifies the current trends of literature and further highlights the existing gaps and potential research opportunities.

4. Phase 2: Conducting the SLR

4.1. Carry out a comprehensive, exhaustive search for primary studies

To obtain a sense of the current state of Green IT/IS studies, both academic journals and conference proceedings publications were examined. In terms of the academic journals, the review began with a search of seven premier IS academic journals that are: *Management Information Systems Quarterly*, *Information Systems Research*, *Journal of Management Information Systems*, *Journal of the Association for Information Systems*, *Communications of the ACM*, *European Journal of Information Systems*, and *Information Systems Journals**. However, as only five "issues and opinions" articles related to Green IS and Green IT were identified in MIS Quarterly, then, the search expanded to other journals and conference proceedings.

* These seven journals are proposed as the top journals of IS based on Association for Information Systems lists of high ranking journals at the time of the review:

Specifically, following Levy and his colleague's (2006) suggestion, the *Journal of Strategic Information Systems*, *Journal of Information Technology*, *Journal of Computer Information Systems*, *Information Systems Research*, *Information Systems Frontier*, *Information and Management*, *Communications of the Association for Information Systems*, *Australian Journal of Information Systems*, and *Academy of Management Journal* were added to the search list. Further, the search scope expanded to utilizing established databases such as, Emerald, ACM digital library, ScienceDirect, and Google Scholar. The IS conferences that were targeted were determined on the basis that these are conferences that are supported by the Association of Information Systems (AIS), which is the premier global organization for academics in IS. Hence, the proceedings of the *International Conference on Information Systems (ICIS)*, *Hawaii International Conference on System Sciences (HICSS)*, *American Conference on Information Systems (AMCIS)*, *Australian Conference on Information Systems (ACIS)*, and *Pacific Asia Conference on Information Systems (PACIS)* were reviewed. Furthermore, additional studies from other journals or conferences were included, on the proviso that they should be relevant and useful to this study such as the proceedings of the conferences related to ICT and sustainability including *ICT for Sustainability (ICT4S)*, *International Symposium on Environmental Software Systems (ISESS)* and *Environmental Informatics (EnviroInfo)*". The following paragraphs describe the process that was pursued for the searches of this research study.

Initially, the search keywords for conducting a review were selected. Since the selection of keywords is related to the quality of results, general terms were selected with the aim of confirming that most of the related studies are included. The final search stream was selected after performing a pilot test that consisted of the following Boolean expressions: "(A1 OR A2 OR A3 OR A4) AND B AND (C1 OR C2 OR C3 OR C4 OR C5 OR C6)", were the search expressions that are provided in Table 1.

Table 1
Search expressions

A1. Information Technology	B. Green	C1. Environment
A2. IT		C2. Environmental
A3. Information Systems		C3. Environmentally
A4. IS		C4. Sustain
		C5. Sustainable
		C6. Sustainability

The search was completed after defining the search streams and using the selected journals and conferences. To manage and organize the results a Microsoft Excel file, combined with the reference management software application of Endnote were used for this phase of the SLR.

4.2. Article selection approach

The publications that were to be included for this study were completed in five phases that are outlined in Table 2. The purpose of this selection procedure was to identify and select the papers that were then matched with the objectives

of the systematic literature review. As the selected keywords for the search stream were too general, it was not expected that all the obtained papers were included in the selection process. The Endnote reference manager helped the researcher team to manage and identify the duplicate references more efficiently and with the generation of an integrated file.

The inclusion and exclusion criteria were used to ensure that the SLR process included only the relevant articles. The inclusion and exclusion criteria are presented in Table 3. To assess the quality of included papers, the quality assessment criteria proposed by Dybå and Dingsøy (2008) was adopted. The criterion is presented in Table 4.

Table 2

Inclusion phases

Phase	Phase description
P1	Selection of studies based on the conducted search.
P2	Screening: inclusion based on the inclusion criteria.
P3	Screening: exclusion based on the exclusion criteria.
P4	Screening: exclusion based quality assessment criteria.
P5	Confirmation

Table 3

Inclusion/exclusion criteria

Inclusion criteria

- Directly or indirectly answers any one or more defined research questions.
- Focus on environmental sustainability through utilizing ICT.
- Was published in the years: 2007-2016*.

Exclusion criteria

- In form of book and overhead presentation.
- External to IS research field.
- Papers when only abstract and no full text were available.
- Articles that did not match the inclusion criteria.

*2007 has been selected as the base line because the topic was first introduced in the IS community by Elliot in a PACIS 2007 Proceedings.

Table 4

Quality assessment criteria (Dybå et al. 2008)

Quality threshold

1. Is the paper based on research (or is it merely a “lessons learned” report based on expert opinion)?
2. Is there a clear statement of the aims of the research?
3. Is there an adequate description of the context in which the research was carried out?

Rigor

4. Was the research design appropriate to address the aims of the research?
5. Was the recruitment strategy appropriate to the aims of the research?
6. Was there a control group with which to compare treatments?
7. Was the data collected in a way that addressed the research issue?
8. Was the data analysis sufficiently rigorous?

Credibility

9. Has the relationship between researcher and participants been considered to an adequate degree?
10. Is there a clear statement of findings?

Relevance

11. Is the study of value for research or practice?

Based on Dybå and Dingsøy (2008), the 11 criteria covers four main issues associated with the quality of papers selected for the SLR, which are:

- **Quality threshold:** Are the minimum requirement of a research paper met?
- **Rigor:** Has a thorough and appropriate approach been applied to key research methods in the study?
- **Credibility:** Are the findings well-presented and meaningful?
- **Relevance:** How useful are the findings to the IS research community?

The first three criteria were the minimum quality thresholds that were used to exclude the papers that do not meet the objectives of the review. The five criteria (4-8) cover the issue of rigor, which considers the applied

research methodology, data collection tools and techniques, and also the trustworthiness of its findings. Criteria 9 and 10 are related to the credibility of the papers that assures the validity and meaningfulness of findings. The final criteria (11) covers the relevance of the study to the IS research community.

4.3. Article analysis approach

To collect the most relevant information from the selected papers, a data collection form was designed in order to facilitate the process of analyzing the compiled data. This form is presented in Table 5 that is referred to as the data schema. The schema was completed following a further review of selected studies by the researchers. Thereafter, the research team had to agree that all the issues were met when considering the final collected data.

4.4. Summarize and Synthesize Study Results

In this section, the results from the findings of SLR are presented in order to answer the defined research questions.

RQ1: How have Green IT and Green IS evolved?

The concepts of Green IT and Green IS are influenced by, and intertwined with the concepts of IT, IS, sustainability, and environmental sustainability. Therefore, in order to understand how IT and IS contribute to environmental sustainability, an elaboration of the related concepts was attained. In the following sections the concepts of sustainability and environmental sustainability are discussed. Thereafter, the terms of Green IT and Green IS are conceptualized.

Sustainability. Sustainability is a complex and partially developed concept (Mulvihill and Milan, 2007). Due to its multidisciplinary nature, it remains complex and has resulted in various definitions and conceptualizations (Elliot, 2011). This term was popularized in the Brundtland Commission Report issued by the World Commission on Environment and Development in 1987, and defined as the “development that meets the needs of the present world, without compromising the ability of future generations to meet their own needs” (Commission, 1987). Traditionally, the single bottom-line measurement of success for organizations is the generation of profit, known as creation of values for stakeholders (Friedman and Allen, 1970).

Economic sustainability, which is the sustainable generation of profit, is pursued by many corporations, specifically the large ones. The opportunities of improving market share, profitability, and competitiveness have enticed organizations to solely focus on their economic sustainability. However, short-term success can be achieved through the single-minded economic sustainability. In order to achieve long-term success, organizations need to satisfy economic, social, and ecological sustainability simultaneously (Dyllick and Hockerts, 2002). There are three dimensions of sustainability in the definition provided by the United Nations (UN) that are: environmental protection, economic development, and social equality. These dimensions are integrated and interrelated with one another, which means that in order to obtain economic development, society should provide and create a sustainable environment (Ijab et al., 2011).

It was also learnt that a clearer definition and more understandable concept of sustainability should be provided for organizations if success on corporate sustainability issues is to be achieved. Based on Smith et al. (2011), many of the decision-makers of organizations have little knowledge and beliefs regarding the exact nature of sustainability. Therefore, if corporations’ managers do not have enough understanding, it would be difficult for the workforce to abide by any sustainability initiatives. The ultimate goal of the organizations was constituted by satisfying the three interdependent dimensions of “triple-bottom line (TBL)” (Elkington, 1997). TBL suggests that

besides economic efficiency activities, organizations should also engage in activities that are beneficial to both the environment and society. Three dimensions constitute TBL, which are namely: economic sustainability, social sustainability, and ecological sustainability. TBL proposes that besides economic efficiency considerations, organizations should also engage in activities that are positive to nature as well (Elkington, 1994). The relationship between these three TBLs is depicted in Fig. 2.

Table 5

Data schema

Basic information	It includes the title and the author(s) of the paper.
Publication	It refers to whether the publication is journal or conference proceeding.
Year	It refers to the publication year of the article.
Objectives	It refers to the objectives that the paper tries to fulfil.
Filed	It identifies the stream of the paper, whether it is related to Green IT or Green IS.
Focus	It deals with the focus of the paper. It focuses on initiation, benefit, adoption, or design and implementation.
Future work	It proposes the future work and the challenges related to the research questions.

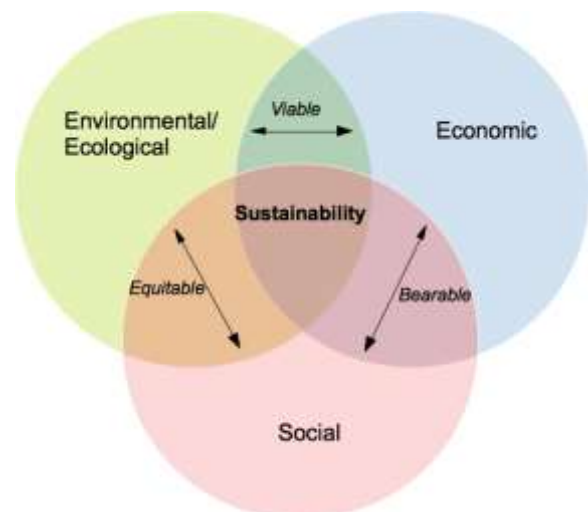


Fig. 2. Triple bottom line (Elkington, 1994)

Some studies have revealed that there are still some organizations that focus on a single bottom line, which is economic sustainability (Chen et al., 2008, Unhelkar, 2011). However, focusing solely on the economic interests as the prime driver is not a long run sustainability approach (Chen et al., 2008). In order to gain long-term sustainability, organizations are required to undertake sustainable approaches beyond mere economic interests (Fadhilah and Ramayah, 2012).

Environmental/ ecological sustainability. Ecological sustainability refers to “the ability of one or more entities, either individually or collectively, to exist and thrive (either unchanged or in evolved forms) for lengthy timeframes, in such a manner that the existence and flourishing of other collectivities of entities is permitted at related levels and in related systems” (Starik and Rands, 1995). Natural resources have long been taken for granted and their

preservation and sustainability are unlikely to be high in organizational agendas. Due to a lack of serious foreseeable economic impacts in the future, societies and the natural environment have been ignored in organizational decision-making processes (Chen et al., 2008). Overall human activities such as agriculture, forestry, and manufacturing rely on a natural environment (Starik and Rands, 1995). Hence, ecological sustainability should have a higher priority in organizational decision-making than economic sustainable development (Starik and Rands, 1995). The natural environment should be added to the list of organizational assets to ensure the long-term viability of the firm (Hart, 1995).

Regarding ecological footprints, there are three criteria for corporations when considering sustainable issues that are: eco-efficiency, eco-equity, and eco-effectiveness (Dyllick and Hockerts, 2002). A myriad of corporations have opted for eco-efficiency as their guiding principle, where their firms' ecological impacts are reflected in financial and economic terms (Schaltegger et al., 1998). Eco-efficiency tends to "make the old, destructive systems less; therefore, only slows down the deterioration of nature with moral proscription and punitive demands" (Chen et al., 2008). Eco-equity focuses on the fair distribution of natural resources among the current and future generations. Like eco-efficiency, conformity to environmental standards is solely motivated by eco-equity that can be superficial (Meyer and Rowan, 1977). Ending the ecological degradations and aiming beyond merely reducing negative ecological impact are the concerns of eco-effectiveness (Chen et al., 2008). Eco-effectiveness seeks the ultimate solutions for environmental problems and often requires mindset shifting and business process transformation.

Based on Chen et al. (2008), one of the solutions that recently has arisen to tackle environmental and social problems is environmental sustainability. It is an important research paradigm that should change individuals behavior and approach towards environmental sustainability (Melville, 2010). Within the literature, there have been minimal studies investigating the relationship between IS and ecological sustainability, which is a noteworthy research stream due to the revolutionary impact of IS on society. Hence, scholars are encouraged to investigate this issue in greater extent and depth (Melville, 2010). The implementation and evolution of Information Technology (IT) has two effects on the environment; first, pressure amounts on the environment due to the provision of a higher efficiency and productivity (Sarkis et al., 2013). Second, a medium is offered that alleviates the pressure on the environment by providing electronic platforms of services and energy saving measures and designs (Cooper and Schindler, 2003, Butler, 2011a, Melville, 2010).

Environmental degradation affects everyone, every society, and every organization; thus, everyone should ascribe responsibility for what they do to impacting the environment (Cooper and Molla, 2013). Can IS be part of the solution? The next section tries to postulate a response to this question.

The need for Green IT and Green IS. The ICT industry is responsible for 2-3% of the global carbon footprint (Mingay, 2007, Kounatze, 2009). As depicted in Fig. 3, the main sources of ICT carbon footprint are the personal computers and data centers (Mingay, 2007). IT contributes to environmental degradation due to energy consumption and waste disposal in the production lifecycle. Furthermore, the disposal of IT equipment is a major problem to the environment because of their applied toxic products. Four million tons of carbon dioxide (CO₂) are produced every year by IT (Ranganathan, 2010).

However, in recent decades, IS have been major contributors to productivity growth in many countries (Watson et al., 2008). One of the important means that IS can be utilized to address environmental problems is using technology. This can be obtained by leveraging technology to a level that offers environmentally friendly products and services, which may constitute to being "one of the biggest opportunities in the history of commerce" (Hart, 1997). Recently, many corporations are concerned with ecological sustainability and have sought solutions by linking this form of sustainability to their corporate strategy. Hence, corporations have begun to recognize and pursue steps to reduce, or eliminate environmental problems; hence demonstrating a larger responsible role in tackling and handling environmental problems. These expectations are further exacerbated by their customers who expect corporations to produce and provide environmentally friendly goods and products. Sustainability requires corporations to be sustainable due to their dominant role in the global economy, where IS would have a major role in transforming the corporations as providers of a sustainable economy (Esty and Winston, 2009).

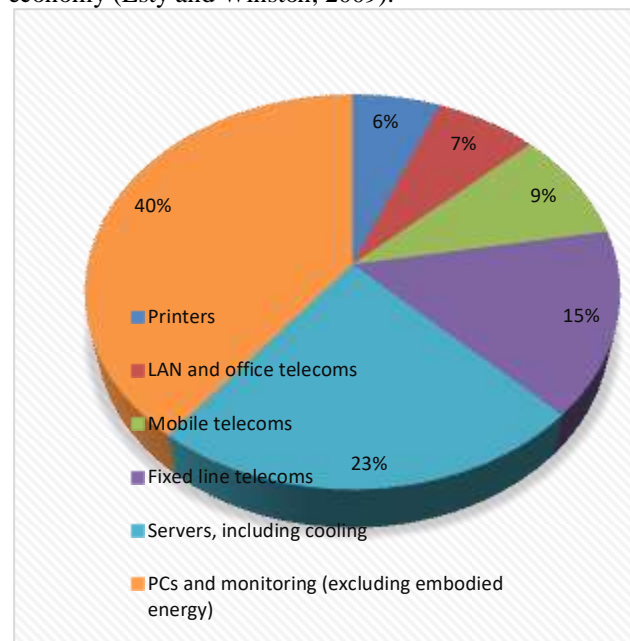


Fig. 3. ICT's global carbon footprint (Mingay, 2007)

Before delving further, this study seeks to distinguish between the terms 'Information Technology (IT)' and 'Information System (IS)'. Based on the online dictionary,

Merriam-Webster, IT is “the technology involving the development, maintenance, and use of computer systems, software, and networks for the processing and distribution of data”. Furthermore, Watson et al. (2008) state that an IT “transmits, processes, or stores information”. From these two definitions it can be interpreted that IT is the technology that is responsible for processing, storing, and networking. Comparatively, IS is “a combination of people, processes, and technologies that enables the processing of digitized information” (Melville, 2010). Watson et al. (2008) define IS as “an integrated and cooperating set of software using information technologies to support individual, group, organizational, or societal goals”. Hence, it can be concluded that IT “comprises the technological foundation of information systems” (Melville, 2010).

Following the above discussion and based on the differentiation between IT and IS, two terms emerge when considering the contributions of IT and IS to the environment: ‘Green IT’ and ‘Green IS’. Both IT and IS have the capability of transforming society to a more sustainable one (Fuchs, 2008). The role of IT/IS in attaining environmental sustainability is twofold. Asserted by Elliot (2007), IT has been considered as one of the significant contributors to energy consumption and pollution. In the United States of America (USA), IT is accountable for 2% of the total CO₂ emission (Mingay, 2007). The energy efficiency of data centers and affiliated hardware have been criticized regardless of their improvements. In France, 13.5% of the overall electricity consumption is gained from IT, despite the continuous efforts to make them energy efficient (Fauchaux and Nicolai, 2011).

We agree that there are many definitions of Green IT and Green IS available in the literature but for the purpose of this paper we have scoped it to the definitions as shown below:

- Green IT has been conceptualized in a number of ways, with wider or narrower scope, and with a variety of terminologies and concepts. Green IT is the systematic application of practices that enable the minimization of the environmental impact of IT, maximize efficiency and allow for company-wide emission reductions based on technology innovations (Elliot, 2011, Erek et al., 2011). Furthermore, Murugesan (2008) defined Green IT as the study and practice of designing, manufacturing, using, and disposing of IT products such as computers, servers, monitors, printers, storage devices, and networking and communications systems - efficiently and effectively with minimal or no impact on the environment. Green IT is not only about the technology and environment; it also endeavors to achieve economic feasibility and improved system performance and use, while abiding by social, legal and ethical responsibilities within organizations (Elliot, 2007, Murugesan, 2008).
- A broader scope, defined as Green IS by Watson et al. (2008), includes the use of information systems to

enhance sustainability across the economy. This view includes improving efficiency in industries that are major sources of GHG emissions, such as the transportation, manufacturing, and energy sectors.

In 2008, Green IT was selected as the most important strategic technology by CIOs (Watson et al., 2008). Green IT emphasizes mostly energy efficiency and equipment utilization where the main issues addressed by Green IT are:

- Designing energy efficient IT equipment
- Energy efficient thin clients instead of personal computers
- Virtualization to run several operating systems on one machine instead of several ones
- Reducing data centers’ energy consumption
- Providing power to data centers from renewable energy sources; and
- Electronic waste reduction from obsolete computing equipment.

In contrast Green IS, refers to “the design and implementation of information systems that contribute to sustainable business processes” (Watson et al., 2008). As discussed by Seidel et al. (2012), an implemented Green IS does not necessarily lead to a green business (see Fig. 4), as organizations should understand how technologies will facilitate their businesses processes so that they can understand the capacities of the change, its implications, and to also manage the change itself.

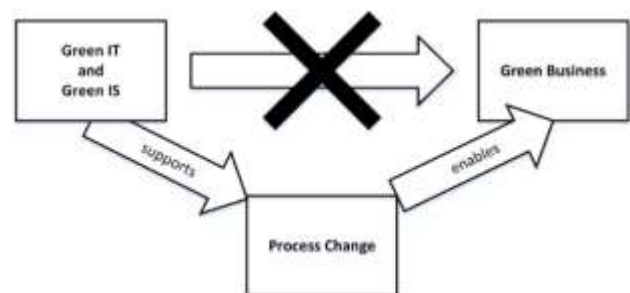


Fig. 4. Relationship between Green IT/IS and green business (Seidel et al., 2012)

A role that can be played by IS for environmental sustainability can be classified in three ways, which are an enabling, promoting, and transformative power (Ijab et al., 2011). An enabler role is to induce changes to business processes of an organization, while a promoter role refers to changes in the behavior of individuals within the organization. The transformative power of IS transforms society into an environmentally sustainable one (Watson et al., 2010). IS has an important role when designing, implementing, and executing business processes to a sustainable level (Seidel et al., 2012). For example, Green IS helps organizations to:

- Reduce their transportation costs by utilizing fleet management systems and dynamically routing vehicles to avoid traffic congestions and minimize energy consumption.

- Tracking environmental information about their product creation, components, and service fulfillment.
- Provide customers with appropriate information such that they can be made capable of making more effective and convenient green decisions.
- Support team work and meetings for the corporation's employees who are distributed around the globe. By providing such support, the workforce's business travel and impacts on the environment are reduced. The role of IS becomes pertinent at this point as it can support a corporation by providing remote working products and services that promote collaboration, group document management, knowledge management, and so forth.

Green IS also provides more potential opportunities for organizations than Green IT, as it has the potential to handle larger problems. For example, it can enable an entire system to be more sustainable in comparison to reducing the energy required to operate IT (Watson et al., 2008). However, Green IS and sustainable development should not be misinterpreted as the operating costs associated with the functioning and operations of a corporation. Rather, they should be considered as the opportunities of increasing productivity, reduce costs, and improve profitability. Many forms of corporate waste are the results of poor environmental practices such as, energy inefficiency, unused resources, noise, heat, and emissions which are all absent from economic efficiency. "Firms that actively pursue Green IS to create sustainable business practices are doing the right thing for their community, customers, investors, and future generations" (Watson et al., 2008).

RQ2: What are the primary studies on Green IT and Green IS?

This section summarizes Green IT/IS studies across the main sources related to IS and sustainability (journals and conference proceedings), across different years, specifically related to the IS domain. The approach utilized for conducting the search and selection of related studies is shown in Fig. 5. The initial search was conducted through the selected outlets by using the defined search stream explained previously. The initial search resulted in an overall number of 556 publications including 91 journal articles and 465 related conference proceeding papers. Following the inclusion and exclusion criteria (see Table 3), 194 papers were removed from the initial list comprising 12 deleted journal articles and 182 conference papers being taken away that led to a refined list of 362 papers. Then application of the quality assessment criteria and final confirmation of authors reduced the list of papers to be included for this study to 67 journal articles and 256 conference proceeding papers.

Table 6 exhibits the counts of papers extracted for both the journals and conference proceedings of primary IS outlets together with other aforementioned resources. Fig. 6 illustrates the summarized details and exhibits the growing

nature of the field. This information should assist academic researchers and practitioners in identifying the potential sources of Green IT/IS articles and also to identify potential IS outlets when identifying related research.

Introduction of the 'Green' concept was initially introduced to the IS field in 2007 at the Pacific Asia Conference of Information System (PACIS) by Elliot (2007), where the author tried to increase the awareness and understanding of the environmental sustainability issues associated with ICT, whilst the topic was inaugurated in IS journals in 2009.

Since the first publication to the present time (2016), an overall number of 67 Journal articles and 256 conference proceedings have been published. Furthermore, Fig. 7 also depicts that the Green IS topic has gained more emphasis in research from the period 2010/2011, which we are assuming is due to a special issue titled: "Information Systems and Environmental Sustainability" by the premier IS journal MIS Quarterly in 2010/2011.

Following literature reviews conducted by Califf et al. (2012) on energy informatics, Brooks et al. (2012) on Green IS, and Brooks et al. (2010) on Green IT, studies on Green IT and Green IS can be categorized in four groups, which are: "benefits", "initiation", "adoption frameworks", and "approaches and strategies". A summary of the description of these categories is provided in Table 7. An attempt was made by the research team to clearly define these categories and categorize them further, which resulted in Table 8. Table 8 exhibits the breakdown of the categories of the reviewed literature based on the descriptions provided in Table 7. Table 9 provides a sample of academic literature and in the following subsections, a discussion of the categories is offered.

Benefits. Thirty-two percent of Green IT/IS studies discussed the benefits that can be gained from the adoption and usage of green initiatives; whether organizationally or individually. After reviewing the articles associated with the benefits of Green IT and Green IS, two major categories of benefits can be identified: cost and environmental benefits. Most of the articles identified for this review aimed to highlight the potential benefits of adopting Green IT/IS initiatives, whether monetarily or environmentally. While in the review articles by Brooks et al. (2010) and Brooks et al. (2012) the focus was more on the benefits of Green IT adoption. In Brooks et al. (2012) literature review emphasis was slightly shifted to the benefits that are provided by the adoption of Green IS as it gained more interest within academic research from 2012 onwards (see Fig. 5). For example, in a study by Erskine and Füstös (2013) the cost benefits and environmental performances that are gained by adopting desktop virtualization within higher education institutions are assessed. In a study by Brauer et al. (2015), a literature review discusses the environmental sustainability opportunities that are provided by Green IS such that smart cities are provided. Furthermore, the benefits that Green IS provides for the natural environment are discussed in the paper by Wang et al. (2015).

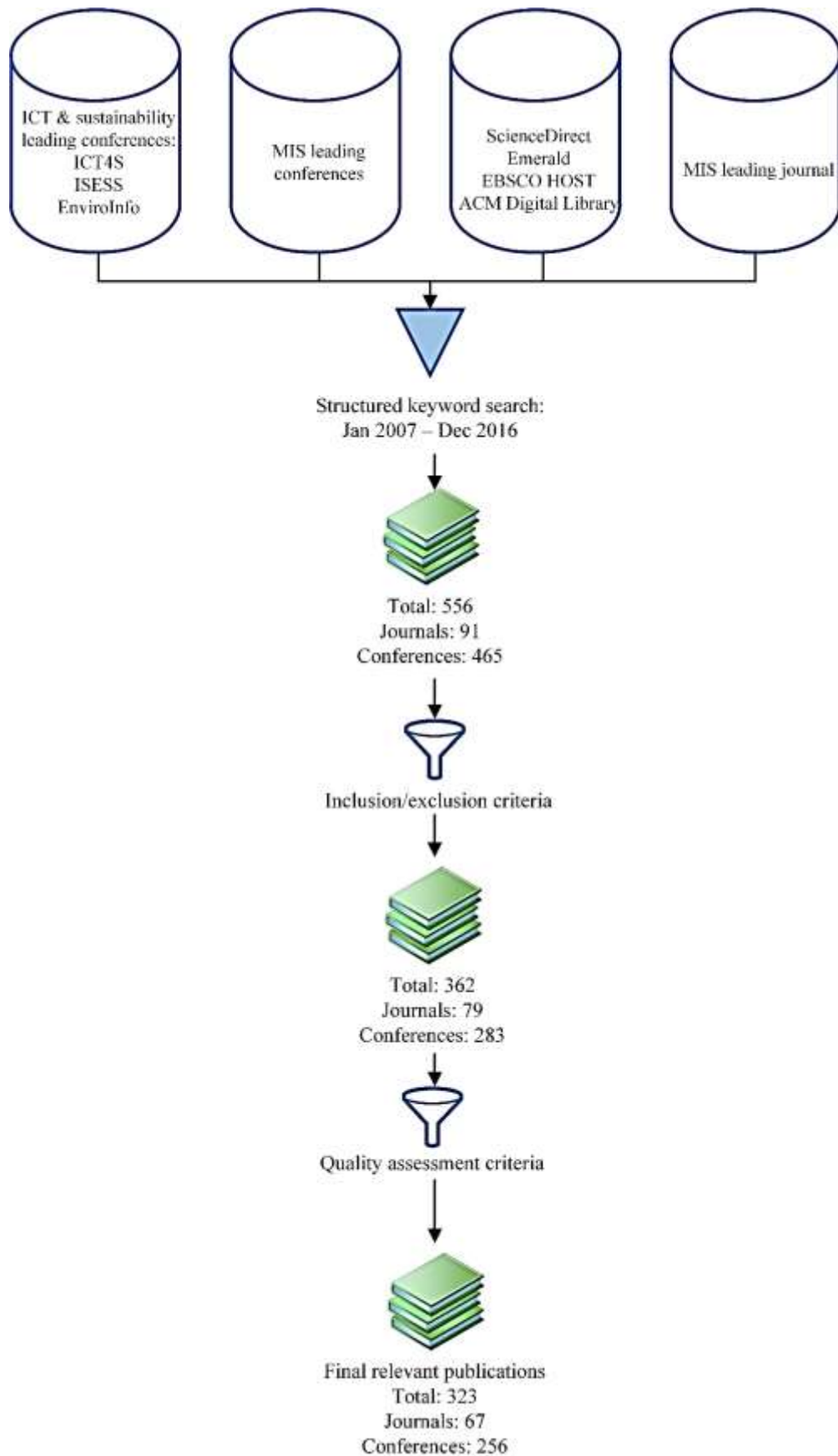


Fig. 5. Publication collection method flow

Table 6
Green IT/IS papers published in premier journals and conferences

	Green IT/IS papers published in journals by year																	Green IT/IS papers published in conference proceedings by year										
	MISQ	ISR	JMIS	JAIS	ACM	EJIS	ISJ	JSIS	JIT	JCIS	ISR	ISF	IM	CAIS	AJIS	AMJ	Other	TOTAL	ICIS	HICSS	AMCIS	ACIS	PACIS	ECIS	ICT4S	ISESS	EnviroInfo	TOTAL
2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	3	8
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	1	0	0	0	2	5
2009	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	3	1	1	3	2	3	1	0	3	10	24
2010	2	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	5	3	2	10	2	2	2	0	0	2	23
2011	1	0	0	0	0	0	0	5	0	0	0	0	1	4	0	4	4	15	4	1	9	1	4	4	0	1	1	25
2012	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	4	6	11	1	15	0	3	4	0	0	5	39
2013	3	0	0	1	0	0	0	0	0	0	0	8	1	1	0	0	4	18	3	2	9	0	8	1	7	5	5	40
2014	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	4	7	6	2	8	0	4	4	9	0	10	43	
2015	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	3	6	0	1	5	0	3	5	6	2	5	27
2016	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	3	6	3	0	6	0	4	3	6	0	0*	22
Total	6	0	0	2	0	0	0	5	0	6	0	9	2	6	8	0	23	67	31	10	65	7	33	24	28	15	43	256

Full name of the journals listed:
 MISQ – Management Information Systems Quarterly
 ISR – Information Systems Research
 JMIS – Journal of Management Information Systems
 JAIS - Journal of the Association for Information Systems
 ACM - Communications of ACM
 EJIS - European Journal of Information Systems
 ISJ - Information Systems Journals
 JSIS - Journal of Strategic Information Systems
 JIT - Journal of Information Technology
 JCIS - Journal of Computer Information Systems
 ISR - Information Systems Research
 ISF - Information Systems Frontier
 IM - Information and Management

CAIS - Communications of the Association for Information Systems
 AJIS - Australian Journal of Information Systems
 AMJ - Academy of Management Journal
 Other – Articles extracted from other databases

Full name of the conferences listed:
 ICIS - International Conference on Information Systems
 HICSS - Hawaii International Conference on System Sciences
 AMCIS - American Conference on Information Systems
 ACIS - Australian Conference on Information Systems
 PACIS - Pacific Asia Conference on Information Systems
 ICT4S – ICT for Sustainability
 ISESS - International Symposium on Environmental Software Systems
 EnviroInfo – Environmental Informatics

* Authors could not access to the proceeding since it was password protected.

The conclusion about the benefits category studies is that, while many organizations have heightened awareness regarding Green IT and Green IS, the adoption of these initiatives is more beyond the simple energy savings purposes. As a study revealed, energy savings and consequently lowering costs were the major reasons for Sun Microsystems Australia to adopt Green IT initiatives (Murugesan, 2008). Hence, it can be argued that by narrowing the benefits of Green IT and Green IS solely to cost savings may limit the potentials of these initiatives and prevent corporations from considering Green IT and Green IS in a strategic perspective.

Initiation. When considering initiation, the question of “when to adopt Green IT/IS?” emerged as an important

aspect of consideration. An important research study by Molla et al. (2009) proposed a model for evaluating the readiness of organizations when adopting Green IT. The study also identified five important factors that significantly influence and motivate corporations to practice Green IT initiatives: attitude, policy, practice, technology, and governance. To further this area, a readiness matrix was developed to classify the motivations of Green IT (Molla, 2009a). Later, in 2011, Molla et al (2011) finalized the Green IT readiness model named as ‘G-Readiness’ that was empirically investigated and tested. In a more recent study, Grant and Marshburn (2014), proposed a model of enablers and inhibitors of Green IS implementation within corporations using a lens from the

institutional theory, status quo bias, and management fashion theory.

By reviewing the articles related to the initiation of Green IT/IS initiatives, it can be concluded that most of the studies are mainly focused upon macro level factors and monetary cost-benefit assessments that motivate corporations to practice these green initiatives. For example, a 2008 report published in CIO.com was commented upon by Michael Dell where it was identified that the primary factor of consideration by managers when initiating Green IT initiatives is cost-saving; whereas, in comparison, the regulatory and stakeholder pressures may have a lesser influence (Beach, 2008). Furthermore, Burnham (2008) reported that the main factor influencing the initiation of Green IT is economic considerations, specifically when economic crisis occur. In such cases, CIOs might reduce or even eliminate the budget for Green IT/IS initiation. Besides these rational considerations, Sarkar and Young (2009) highlighted that when considering Green IT initiatives, managers will be influenced by awareness programs.

Approaches and strategy. The majority of selected studies (133 or 41%) was focused on investigating the approaches and strategies of Green IT/IS. When considering approaches and strategies, the publications in this category offer suggestions of the benefits that Green IT/IS initiatives provide. For example, Loock et al. (2011) proposed a strategy to appropriately design Green IS in order to conserve more energy. Brandt et al. (2013) comparatively suggested a designing approach for IS artifacts in order to control energy consumption. Hilpert et al. (2014b) proposed an approach to design a mobile application for monitoring Green House gases (GHG) emission in meat production processes, which it was felt would further increase the awareness of environmental sustainability. In terms of designs and the environment, Nuss (2015) proposed a design for an environmental management

information systems (EMIS) that provided economic data combined with environmental data for both the consumers and suppliers of electrical energy.

A diverse perspective is offered by Brooks et al. (2012) who defined three eco-goals of Green IT/IS initiatives: eco-efficiency, eco-effectiveness, and eco-collaboration. Eco-efficiency is defined as “the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing environmental impacts and resource intensity throughout the life cycle. This is to a level at least in line with the earth’s estimated carrying capacity” (DeSimone and Popoff, 2000). Eco-effectiveness implies the design of a product in which “celebrate interdependence with other living systems [...] and work within cradle-to-cradle life cycles rather than cradle-to-grave ones” (McDonough and Braungart, 1998). Eco-collaboration is defined as “collaboration between companies and other stakeholders, such as partners and customers, to maximize the benefit of eco-efficiency and/or eco-effectiveness through product and/or business process redesign”. After determining the papers in this category of strategies and approach, it can be concluded that a large number of the studies are associated with eco-efficiency that is mainly derived from cost savings and energy efficiencies (Nanath and Pillai, 2012, Corbett et al., 2010, Wati and Koo, 2010, Uddin and Rahman, 2012, Huang, 2009, Bai and Sarkis, 2013). It can also be found that there are fewer studies discussing the approaches that enhance eco-effectiveness (Lubbecke et al., 2015, Reiter et al., 2014, Pitt et al., 2011, Zhang and Xie, 2015). The missing eco-goal among the studies is the eco-collaboration aspect. Given that Green IT/IS are complex and multi-dimensional phenomena, researchers are recommended to pay more attention on eco-effectiveness issues; more specifically eco-collaboration such that greater opportunities and benefits from Green IT/IS initiatives can be identified.

Table 7

Definitions of the categorization groups used to analyze studies conducted in Green IT/IS

Category	Description
Benefits (cost and environment)	The studies in this group discuss the benefits gained from the application and utilization of Green IT and Green IS. There are two major categories of benefits: environmental and cost benefits.
Initiation	When to adopt Green IT/IS is the focus of this category. The studies in this group discuss the readiness of organizations to successfully adopt these two initiatives.
Adoption framework	The studies in this group discuss internal and external factors that motivate and influence ones to adopt Green IT/IS.
Approaches and strategies	The studies in which discuss different approaches to treat and manage Green IT/IS initiatives are categorized in this group.

Table 8

Categories of reviewed literature

Category	No. of Articles		Total (%)
	Green IT	Green IS	
Benefit (cost and environment)	42	64	32%
Initiation	30	13	13%
Adoption framework	26	21	14%
Approaches and strategies	38	95	41%

Note: One article may belong to multiple categories.

Table 9

Sample of reviewed studies

Reference	Objective	Category
Curry and Donnellan (2012)	The benefits gained by practicing sustainable IT in Intel.	Benefit
Seidel et al. (2015)	Investigating the key benefits provided for organizations through the adoption and implementation of Green IS.	Benefit, approaches and strategy
Nishant (2012)	Investigating the influence of adopting Green IS on the performance of organizations.	Benefit, initiation
Brauer et al. (2015)	Application of Green IS to foster environmental sustainability in Smart City	Benefit
Molla et al. (2011)	Green IT readiness model for Green IT initiation in organizations.	Initiation
Opitz et al. (2014b)	To develop a readiness model for Green BPM	Initiation
Angeles and Frederickton (2015)	Investigating the Green IT initiatives within IBM, DELL, and HP	Initiation, benefit
Oppong-Tawiah et al. (2014)	Encouraging Sustainable Energy Use in the Office with Persuasive Mobile Information Systems	Strategy and approach
Ekman et al. (2015)	To change environmental behavior	Strategy and approach
Parker et al. (2014)	Strategy to incorporate environmental awareness	Strategy and approach
Zhang and Xie (2015)	To propose a model for sustainable production development	Strategy and approach
Chen et al. (2009)	Organizational adoption of Green IT/IS	Adoption framework, benefit
Mancha et al. (2014)	Investigating the green behavior towards the adoption of green IT	Adoption framework
Deng and Ji (2015)	Organizational Green IT adoption	Adoption framework
Dalvi Esfahani et al. (2015)	To propose a Green IT adoption model	Adoption framework
Koo and Chung (2014)	Smart Green IT adoption behavior.	Adoption framework
Koo et al. (2015)	Adoption of smart grid	Adoption framework, benefit
Pollard (2015)	Green IT adoption framework	Adoption framework

Adoption frameworks. Adoption publications have attempted to propose frameworks for understanding the factors that influence individuals when adopting, or in simpler terms, to accept Green IT/IS initiatives. Of the 323 studies, 47 (14%) belong to this classification. The initial and one 2008 published, adoption paper proposed an adoption model for Green IT (Molla, 2008). It was later on that a larger influx emerged in 2013 and 2014, when environmental issues were being emphasized much more within the media and policymakers. Of the 47 Green IT/IS adoption publications, 26 investigated the adoption of Green IT, with 21 articles emphasized Green IS.

Of the 47 articles identifying and understanding adoption frameworks, 10 were research-in-progress papers and the majority were (37) complete publications that contained applied studies of an empirical nature. In terms of the complete papers, there was a reliance on different methods when collecting data in which the quantitative research method together with a survey approach was most popular. Of the 37 studies, 30 (81%) used a quantitative (survey) method while the remaining papers applied other research methods, such as, a qualitative (interview), or a multi-method approach. What was also learnt is that various contexts were employed for Green IT/IS adoption studies. These contexts include organizations and households. In the household context, the behavior of citizens, or consumers was investigated when adopting diverse Green IT/IS initiatives. For example, in a study by Wunderlich et al. (2013), the authors investigated the influence of personal values on the Green IS adoption behavior. In another study, when considering energy savings, and used as an example for Green IS, Kranz and Picot (2012) investigated the factors that influence households when adopting smart metering technology.

RQ3: What is the status quo of organizational Green IT and Green IS adoption studies?

With regards to studies of the adoption of Green IT/IS in organizations, classifications occurred on the basis of the levels of analysis. For the levels of analysis, organizational behavior * literature revealed that there are three levels, which are, individual, group, and organization (Bommer et al., 1987). The individual level (micro) focuses on the analysis of individual characteristics that are crucial to manage and to understand behaviors in organizations such as, personality and ability, values, moods, perceptions, attitudes and motivations. The second level is the group or team (meso) characteristics and processes where group is referred to as “two or more people who interact to achieve their goals” and team is defined as “a group in which members work together intensively and develop team specific routines to achieve a common group goal” (Bommer et al., 1987). A group can influence its members through different ways such as leadership, communication, and decision making. Many studies also found that the characteristics of a whole or overall organization (macro) have a pertinent influence on the behavior of its individuals and groups. For example, the values and beliefs of an organization’s culture can impact the behavior of individuals. Furthermore, the organization’s ethical behavior can shape the behavior and attitude of individuals and groups; hence influencing their desire to work towards achieving the goals of the organization.

Of the 37 complete-research studies on the adoption behavior, 32 of them were conducted in the context of organizations, where the unit of analysis identified that 86% of the studies were at an organizational level and 14% of them at an individual level, with one article being a conceptual model that offered no analysis. What was also

* “Organizational behavior (OB) is the study of the many factors that have an impact on how people and groups act, think, feel, and respond to work and organizations, and how organizations respond to their environments” (Bommer, 1987)

learnt is that there are no studies within the list that examined the adoption behavior at the group (or meso level). For example, Chen et al. (2011a) proposed a model to investigate the adoption of Green IS within organizational decision-makers using the organizational level of analysis. To that end, a model was developed and based on the institutional theory and natural-resource-based view of the firm, where it was concluded that mimetic and coercive pressures significantly impact Green IS adoption focusing on product stewardship. At the individual level of analysis, Molla et al. (2014) investigated the influence of Green IT attitudes and beliefs when considering the intention of IT professionals where their behavior is environmentally positive, which leads to them practicing Green IT initiatives.

In terms of the sample size, the average (mean) sample size of respondents for the quantitative studies within organizations was 205, of which a large number of studies utilized samples or participants drawn from various managerial levels as they had decision-making roles such as, CIOs, CEOs, senior managers, and IT managers. In a few studies, the adoption behavior was investigated from the point of view of employees. As depicted in Fig. 8, among the most frequently investigated regions were Oceania (e.g., Australia and New Zealand), East Asia (e.g., Hong Kong, China, and Taiwan), Europe (e.g., Germany, UK, and Turkey) and, North America. A few studies had used research sites drawn from South and Southeast Asia (e.g., Malaysia, Singapore). The geographic distribution of studies revealed that of these 32 studies considering the adoption of Green IT/IS initiatives within organizations; the majority were conducted in developed countries, with a few studies investigating the adoption behavior of these initiatives within developing countries.

In terms of theories and models, there were various theories and models that have been applied by scholars when investigating the behavior of individuals when adopting Green IT/IS. The exclusion of research-in-progress papers, and the level of analysis basis led to the formation of Table 10. Table 10 exhibits the theories and models applied to the 32 reviewed studies of organizational Green IT/IS adoption. Of the 32 studies, the majority of them (19, or 59%) investigated the adoption of Green IT, with only 13 (41%) emphasizing Green IS and its initiatives.

Organization-Level Theories. The theories in this group aim to explain the adoption behavior of individuals at an organizational level. Table 10 identifies an overall 9 theories being applied and used at this level. Table 10 also shows and discusses theories that are of importance and used more often than others.

What was found is that a prevalent theory at the organizational-level is the institutional theory. Scott (1995) initially applied institutional theory to identify three ways that organizations influence individual cognition and behavior: structures of signification, legitimization, and domination. Orlikowski et al. (1995) argue that “individuals utilize these institutional structures of signification, legitimization, and domination to make sense of the technology, garner the resources needed to infuse it into work processes, business activities, and strategies, and undertake the improvisational actions needed to assimilate the technology”. For example, in a study by Chen et al. (2011a), the adoption of Green IS was examined using the lens of institutional theory where the impact of mimetic pressure, coercive pressure, and normative pressure on the adoption behavior of managers was examined. For this study, empirical analysis was utilized to support the main effects of mimetic and coercive pressures. Other examples of institutional theory studies are: Coffey et al. (2013), Gholami et al. (2013), and Chen et al. (2009).

Another theory that emerged from the review was a natural-resource-based view of the firm. To explain this theory a study developed a natural-resource-based view of the firm by examining the competitive advantage of a firm that is built upon its capabilities to engage green initiatives to its economic activities. For this purpose, three green strategies with different orientations were identified, which are, pollution prevention, product stewardship, and sustainable development (Hart (1995). A different study by Chen et al. (2011a) utilized the natural resource based theory combined with institutional theory to study the adoption of Green IS initiatives for three green strategies of the firms (i.e., pollution prevention, product stewardship, and sustainable development). The empirical analysis of the study revealed a great motivation for Green IS adoption that focused on product stewardship.

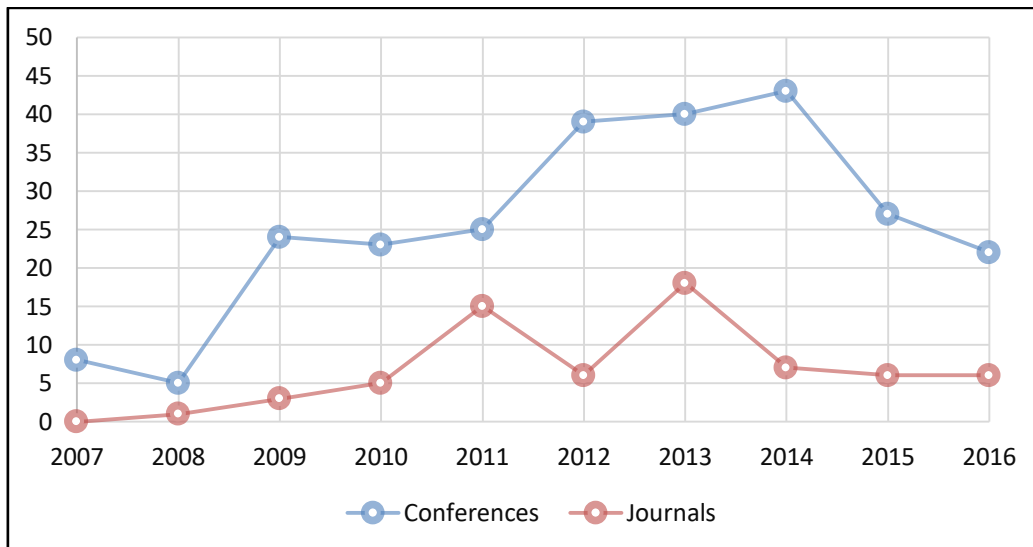


Fig. 6. Journals and conferences outcomes related to Green IT and Green IS from 2007 to 2016

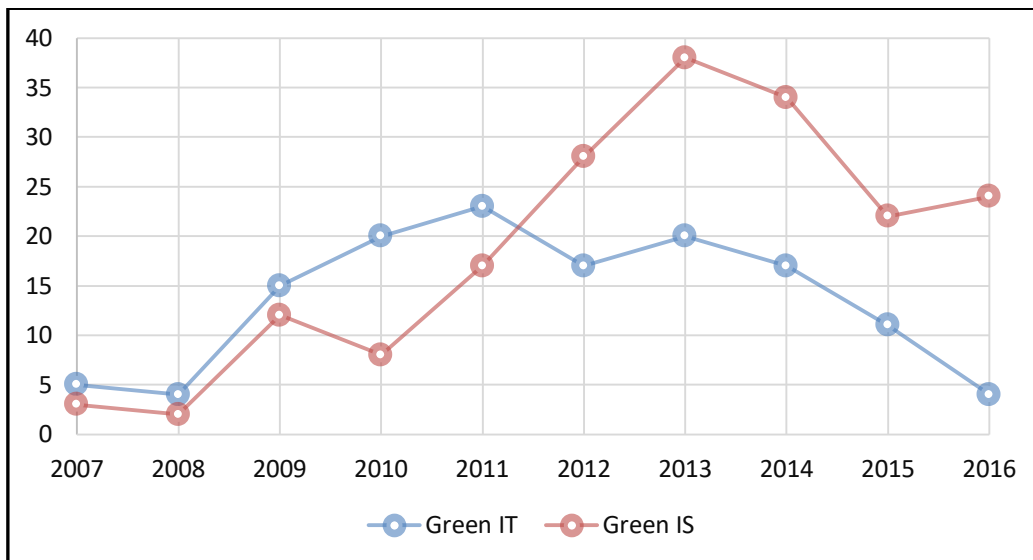


Fig. 7. Trend of Green IT and Green IS research within 2007-2016

Individual-Level Theories. Individuals also work in, and are employed within organizations; hence the individual-level group theories were also considered in this study. Individual level group theories aim to explain the adoption behavior of Green IT/IS at a personal/individual level. Table 10 shows that 9 individual-level theories were used at this level. Some of the mostly used and significant theories are selected and discussed below.

A major theory that is used to study individuals' behavior towards the adoption of Green IT/IS is the theory of planned behavior (TPB). TPB was developed by Ajzen (1991), which is an extension of the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980). TPB has been one of the most important cognitive social theories in explaining and predicting various behaviors (Pavlou and Fygenson, 2006). Based on this theory, the proximal determinant of a behavior is a behavioral intention, which in turn, is determined by attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC). Attitude

captures the overall evaluation of an individual to perform a specific behavior. SN refers to the perception of a person regarding the expectations of important others about the target behavior. PBC is defined as an individual's perception of how easy or difficult it would be to perform a behavior (Ajzen, 1991). Following Ajzen and Fishbein (1980) seminal work, an emergence of studies utilizing TPB occurred with the theory being a largely cited psychology based theory in the context of technology adoption (Chen et al., 2011b, Coombs, 2009, Ferratt et al., 2010, Weigel et al., 2014). It was also learnt that TPB is often combined with complementary theories and model to investigate the adoption of information systems (Leonard et al., 2004, Lin et al., 2011, Weigel et al., 2014, Yang, 2012, Lee, 2009).

In the context of Green IT/IS adoption studies, TPB is the mostly used theory within individual-level theories when investigating the psychological factors that influence the behavioral intention of people when adopting and practicing Green IT/IS initiatives. For example, TPB has

been employed to investigate in the study by Mancha et al. (2014), they have the environmental behavior of organizational decision-makers to practice environmental friendly initiatives within their corporations (Mancha et al. (2014)). A diverse study expanded TPB with attitudes towards environmental sustainability (generally and specifically) to study the behavioral intention of students towards computer energy saving behavior as an instance of Green IT (Pollard (2015)). Other examples of the application of TPB include studies by Kranz and Picot (2012) and Chow and Chen (2009). As a basis of TPB, TRA has been used to study the green behavior of individuals when practicing Green IT/IS (Mishra et al., 2014, Chow and Chen, 2009).

5. Phase 3: Discussion and Conclusion

Fig. 9 summarizes theories that are most often and not often used for Green IT/IS adoption within organizations research studies, as well as regions around the globe where Green IT/IS adoption within organizations research has occurred. It can be noted that the level of analysis for the majority of the studies is at the organizational-level; whilst a few studies investigated the formation and evaluation of Green IT/IS by examining organizational decision-maker's motives together with their intention to adopt these initiatives. More specifically, a body of research investigating the adoption of Green IT/IS in organizations exists, but such research emphasizes primarily the macro level where the organization itself is the unit of analysis. Furthermore, as discussed previously and depicted in Fig. 8, Green IT gained more prominence in the context of technology adoption within organizations. This is shown in the numbers of published articles, which are 10 articles in total and investigated the factors that influence the adoption of Green IS.

Following the findings in Table 10, it is obvious that most of the studies emphasize the strategic and commercial imperatives as drivers of Green IT/IS adoption, while the level of analysis is organization itself (e.g., Kuo and Dick, 2010a, Kuo and Dick, 2010b, Butler and Daly, 2009). Decisions within the organizations may be made from economic, legal, or moral point of views (Boatright, 2000). Morality is defined as "interlocking set of values, practices, institutions, and evolved psychological mechanisms that work together to suppress or regulate selfishness and make social life possible". Decisions made on the basis of morality are termed as moral decision-making or moral judgment (Kana 2011). Moral decision-making within the organizational context is defined as "those decisions that focus on the best outcome for the majority of people involved" (van Gils et al., 2015). Gully et al. (2006) argued that in order to meet the needs of the firm's stakeholders, including the natural environment, there should be a clearer and more explicit moral decision-making process. Organizations are vessels, which are guided and shaped by

their decision-makers (Sekerka and Stimel, 2012). In the case of environmental sustainability, morally responsible decision-makers must consider whether their firm's mission is aligned with the natural environment. Hence, it can be concluded that while economic and legal imperatives are the obvious motives when adopting new technologies, they are not the sole drivers of Green IT/IS adoption in organizations. Besides the strategic motivations and rational choices when adopting Green IT/IS, moral and ethical decision-making characteristics of individual managers can impact social and ecological responsibilities of organization when adopting Green IT/IS. This claim is also in line with a study by Melville (2010) who says that "... distinctive characteristics of the environmental sustainability context, such as values and altruism, affect intention to use and usage of Information Systems for environmental sustainability".

In addition to extracting information pertaining to Green IT/IS studies and providing an overview to the discipline's current status, this research derived a literature-based research agenda for the organizational Green IT/IS adoption research paradigm by identifying potential research opportunities. These are presented below as a reference for future research in the field. This begins by discussing the Upper echelons theory (UET) (Hambrick and Mason, 1984, Hambrick, 2007) that frames the future research questions proposed by this study. The underlying premise of UET, Fig. 9, is that executives interpret their strategic environment through their personal experiences, values, and personalities, and their strategic choices are made upon those backgrounds (Hambrick and Mason, 1984, Hambrick, 2007). The fundamental idea of this theory is captured by the seminal paper of Hambrick and Mason (1984) where the upper echelons perspective in the organization is a reflection of its top managers (the so called "upper echelons") characteristics. The theory acknowledges that the outcome or performance of organizations is heavily influenced by the individual managers' choices. These in turn are affected by their characteristics (Hiebl, 2014). As a result "strategic choices generally own a great deal of behavioral components and reflect decision makers' idiosyncrasies, such as cognitive base and value preferences" (Chuang et al., 2009). When examined further, it was explained that the upper echelons' characteristics and their strategic choices help to explain organizational performances. What was also suggested is that organizational outcomes can be partially predicted by their top managers' characteristics, based on the notion that their strategic choices are influenced by their cognitive base and their values, "decision makers brings a cognitive base and values to a decision, which creates a screen between the situation and his/her eventual perception of it" (Hambrick and Mason, 1984).

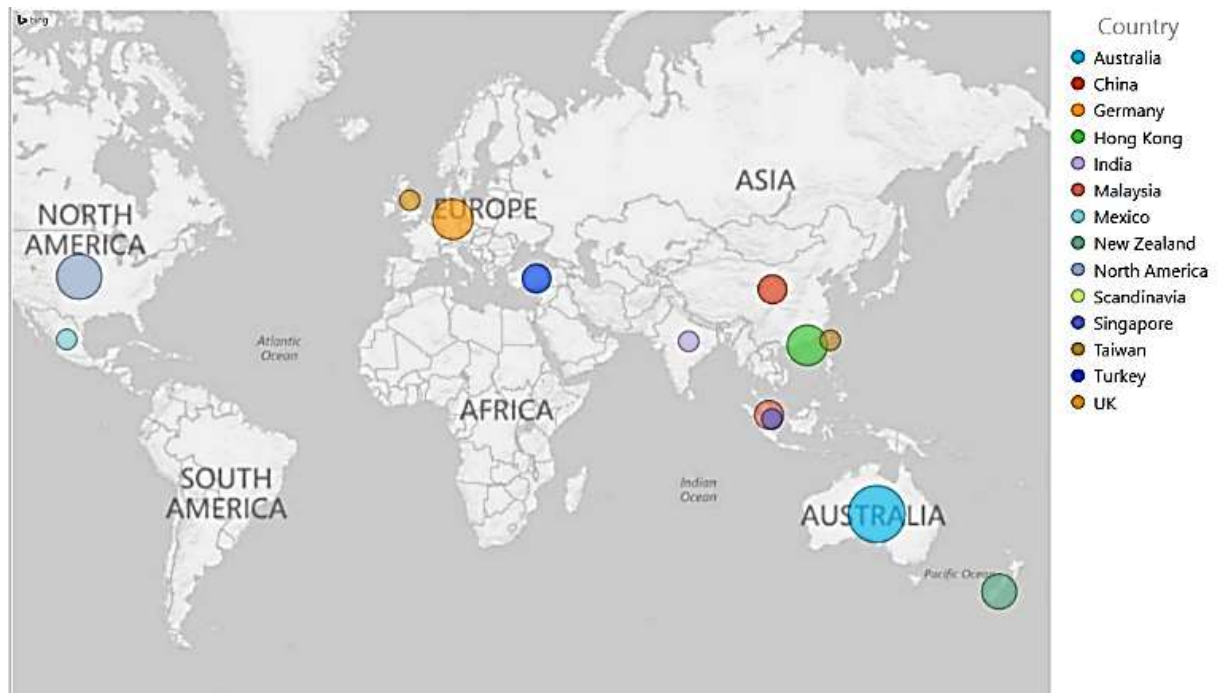


Fig. 8. Studies on organizational Green IT/IS adoption by country

Table 10

Theories and models used in organizational Green IT/IS adoption studies

Theories and Models	References	N
<i>Organization-level theories</i>		
Institutional Theory	Chen et al. (2009), Chen et al. (2011a), Coffey et al. (2013), Deng and Ji (2015), Karanasios et al. (2010)	5
Natural-Resource-Based View of the Firm	Chen et al. (2009), Chen et al. (2011a), Deng and Ji (2015)	3
Technology-Organization-Environment	Nedbal et al. (2011), Lei and Ngai (2013a), Zheng (2014), Johnson et al. (2014)	4
Transaction Cost Theory	Nedbal et al. (2011)	1
Resource-Based-View	Simmonds and Bhattacharjee (2014), Deng and Ji (2015), Yang et al. (2016)	3
Advanced Model of Corporate Ecological Responsiveness	Simmonds and Bhattacharjee (2014)	1
Organizational Culture Theory	Deng and Ji (2015)	1
Organizational Motivation Theory	Molla and Abareshi (2011), Molla and Abareshi (2012)	2
Corporate Ecological Responsiveness	Yang et al. (2013)	1
Topology of Legitimacy	Lin et al. (2013)	1
Stakeholder Theory	Cai et al. (2013)	1
Belief-Action-Outcome	Gholami et al. (2013)	1
<i>Individual-level theories</i>		
Diffusion of Innovation Theory	Nedbal et al. (2011)	1
Theory of Planned Behaviour	Mancha et al. (2014), Pollard (2015), Kranz and Picot (2011), Chow and Chen (2009)	4
Norm Activation Model	Lei and Ngai (2014)	1
Elaboration Likelihood Model	Dalvi Esfahani et al. (2015)	1
Motivation-Ability Theory	Karanasios et al. (2010)	1
Utilitarian Theory	Karanasios et al. (2010)	1
Belief-Action-Outcome	Gholami et al. (2013), Molla et al. (2014)	2
Theory of Reasoned Action	Chow and Chen (2009), Mishra et al. (2014)	2
Technology Acceptance Model	Akman and Mishra (2015)	1

5.1. Upper Echelon Theory (UET)

In organizations, strategic decisions are made by executives in a complex and ambiguous environment based on a frame of reference derived from their past experiences, education, and their functional background (Finkelstein et al., 2009). Hambrick and Mason (1984) introduced the Upper Echelon Theory (UET) in order to identify how organizational outcomes, strategic choices and performance levels can be determined from the characteristics of top

managers and executives. In greater depth, the theory proposes that the behavior of the organization is a reflection of top managers' characteristics and organizational performance can be predicted by understanding top managers and executives demographic and psychological factors. Hambrick and Mason (1984) asserted that: "Organizational outcomes are viewed as reflections of the values and cognitive bases of powerful actors in the organization. It is expected that, to some

extent, such linkages can be detected empirically” (Hambrick and Mason, 1984).

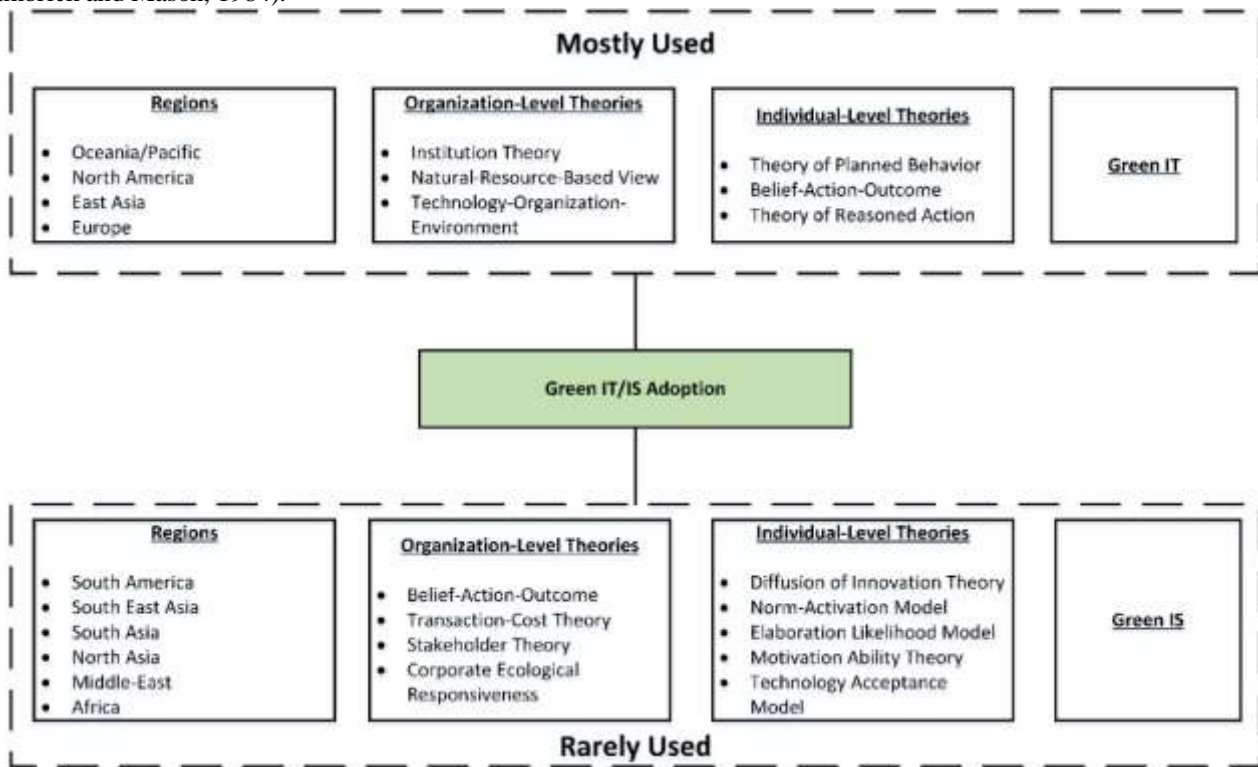


Fig. 9. Scope and focus of literature on organizational Green IT/IS adoption

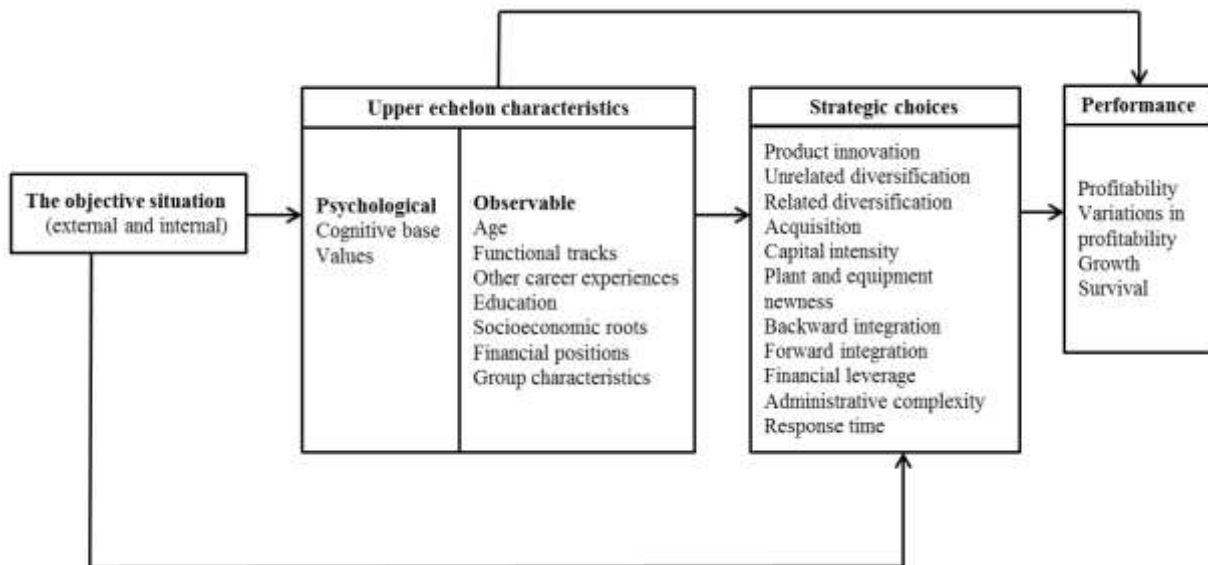


Fig. 10. Upper echelon’s perspective (Hambrick, 2007)

Based on UET, managers align the cognitive base and values as a screen between the situation and the eventual perception of it. The managers’ perceptual view can be conceptualized by taking a sequential view. A manager or team of managers of an organization cannot see and scan every aspect of the organization and its environment. Due to a restricted managers’ “field-of-vision”, their perceptions are further limited because one “selectively perceives” only the phenomena included in the field of vision. Finally, the information selected for processing are “interpreted” which

further are filtered by one’s cognitive and values. Fig. 10 depicts the overall upper echelon theory. It is claimed that the decisions of individuals is shaped based on their interpretation of the situation, where top managers find solutions to problems based on two types of characteristics: (a) their psychological attributes – such as values, beliefs, and cognitions – and (b) their observable characteristics – such as age, gender, working experience, and nationality. In the following sections, the psychological attributes including psychological cognitive base and values, and observable characteristics that are important in moral

decision-making of managers are elicited and discussed in detail.

Psychological Cognitive Base. As people interact with their environment constantly, their constant behavioral pattern can be termed as environmental behaviors. This means that all the activities influence the environment regardless of how insignificant they are (Krajhanzl, 2010). Therefore, environmental behaviors are the ones that have significant influence on the environment. In this sense, the term of “environmentally-relevant behaviors” is also utilized (Stern, 2000).

Most cases of environmental behaviors can be judged and labelled as environmentally friendly or unfriendly based on their impact on the environment. Some cases can be judged easily; for example, commuting by bicycle is more positive to the environment than by car. Also, holidays near the home are more favorable than traveling to another country or even another continent. However, the evaluation and judgment of some other cases are doubtful or significantly demanding (Krajhanzl, 2010), such as “is the attendance at a political meeting about climate change in South Africa where travelling by plane is necessary and environmentally positive?” or “buying a new hybrid car instead of a ten year old one?”. These factors need to be taken into account in the context of environmentally positive behaviors (PEBs) (Krajhanzl, 2010). Based on Kollmuss and Agyeman (2002), ‘proenvironmental behavior’ is simply defined as “behavior that consciously seeks to minimize the negative impact of one’s actions on the natural and build world (e.g. Minimize resource and energy consumption, use of non-toxic substances, reduce waste production)”.

There are a diverse variety of theories in the psychology discipline that can be applied Green IT/IS adoption context studies and study how and why organizational decision-makers adopt Green IT/IS initiatives in order to enhance the performance of their corporation; whether economically or environmentally. Related to environmental decision-making studies a theoretical framework that is prevalent and well known is the theory of planned behavior (TPB: Ajzen, 1985, Ajzen, 1991) or norm activation theory (NAT: Schwartz and Howard, 1981, Schwartz, 1977). These theories provide researchers with a good and initial understanding of individuals’ proenvironmental behavior within society; specifically in identifying some of the important psychological determinants that encourage individuals to engage in societal environmental behaviors such as, knowledge, motivations, values, and attitudes (Ones and Dilchert, 2012). As discussed previously (see Section 4.4.1), TPB has already been applied to various studies when considering the adoption of Green IT/IS. However, an obvious shortcoming of TPB when studying environmental behaviors is that it utilizes a rational-choice framework and self-interest deliberation to explain proenvironmental behaviors, where the individuals’ sense of morality is ignored (Conner and Armitage, 1998, Manstead, 2000). Considering rational self-interests in studying environmental behaviors becomes problematic because concerns for the environment involve including

individuals’ moral elements, which are personal moral norms or feelings of moral obligation towards the environment (Thøgersen, 2006). When speculating whether to engage in proenvironmental behaviors, individuals tend to consider their behavior towards the environment as that containing moral components rather than their rational choices.

The theory that incorporates personal norms in studying prosocial and proenvironmental behavior is NAT. different to TPB, the perspective of NAT is based on morality rather than a cost-benefit assessment. The importance of the application of NAT in studying Green IT/IS adoption was initially introduced by Lei and Ngai (2014). However, the researchers only introduced the significant opportunity of studying personal norms as moral obligation to behave proenvironmentally rather than the whole model. Hence, the opportunity that existed for future researchers would be an investigation of Green IT/IS adoption using organizational decision-makers and the lens of a norm activation theory. There have been efforts to extend the model by integrating it with other theories and factors to perfectly reflect the ethical decision-making process of managers when adopting Green IT/IS. The following potential research questions are proposed:

RQ1: *To what extent do the antecedents of the NAT explain the proenvironmental intention of managers when adopting Green IT/IS?*

RQ2: *What factors can be added to the NAT to better explain the proenvironmental behavior of managers towards the adoption of Green IT/IS?*

Values. The Values Theory defines values as “desirable, trans-situational goals, varying in importance that serves as guiding principles in people’s lives” (Schwartz, 1992). Hence, the values of people are abstract and deep rooted motives, which guide, defend or explain their attitudes, beliefs, norms, and behavior (Rokeach, 1973, Schwartz, 1992).

When individuals are asked to give judgment about stimuli like environment, people, and objects, they often refer to their values as a rule (Brunsrød et al., 2004). When people think about their values, they think of what is important to their in life (Schwartz, 2012). Every individual holds numerous values (e.g., achievement, dominance, security) with different degrees of importance. A particular value may be very important to a person while it is unimportant to another one. Schwartz (1992) specifies main six features of values as follows:

“Values are beliefs linked inextricably to affect.” When values are activated, they are pervaded with feelings. For example, for individuals whom independence is an important value they become aroused when their independence is threatened.

- (1) “Values refer to desirable goals that motivate action.” For example, individuals who value justice and helpfulness are motivated to take actions and pursue their goals.

- (2) “*Values transcend specific actions and situations.*” For example, honesty values may be relevant in business or politics, with friends or strangers. Values are different with norms and attitudes that are specific to actions and situations.
- (3) “*Values serve as standards or criteria.*” The selections and evaluations of actions, policies and situations are guided by values. People decide what is good or bad, worth doing or avoiding, and based on the possible consequences of their cherished values.
- (4) “*Values are ordered by importance relative to one another.*”
- (5) “*The relative importance of multiple values guides action.*” The trade-off between relevant and competing values guides attitudes and behaviors (Schwartz, 1992). Values influence behaviors and actions when they are relevant in the context and are important to the actor (Schwartz, 2012).

The above features are common among all the values; however, what differentiates one value from the others is the type of goal and motivations that it expresses. Following the abovementioned features and based on the goal and motivation of each value, Schwartz (1992), developed a widely accepted value system that was further refined (see Fig. 11) in order to “partition the continuum into a finer set of meaningful, conceptually distinct values with greater universal heuristic and predictive power”. The new value system was then explained in further research by referring to the 19 distinct values that were further categorized based on different orientations; such as, Self-Transcendence vs. Self-Enhancement and Openness to Change vs. Conservation. Self-Transcendence value orientation is reflected by two values of Benevolence and Universalism while two values of Power and Achievement reflect Self-Enhancement value orientation. Openness to Change value orientation is defined by the combination of Self-Direction and Stimulation values, and the values of Conformity, Security, and Tradition construct the orientation of Conservation. The values of Humility and Face are unique as they can be considered as, and treated as distinct values, but could also be included in the Conservation value; whilst Self-Enhancement could be included in the Hedonism value (Schwartz et al., 2012).

As stated by Bansal and Roth (2000), “individual concern for the natural environment is the degree to which organizational members value the environment and the degree of discretion they possess to act on their environmental values”. Business organizations have individuals who have “bounded rationality, cognitive biases, and personal values that direct their actions” (Bansal and Roth, 2000). Bansal and Roth (2000) in their article suggest that managers’ personal values influence their discretion to behave proenvironmentally because (a) values aid managers to differentiate important and unimportant signals (Dutton, 1997); (b) values may encourage organizational members and specifically decision-makers to champion ecological responses (Anderson and Bateman, 2000); and (c) managers are more

likely to change the way their firm operates, if that change is in line with their personal values (Anderson and Bateman, 2000, Gouldson, 1993).

Grojean et al. (2004), asserted that values have a significant influence on organizational behaviors including organizational ethics. Furthermore, Hemingway and Maclagan (2004), proposed that “individual managers’ organizational decisions are driven by a variety of personal values and interests, in addition to the official corporate objectives”. This is also supported in the literature, which stated that the championing of Corporate Social Responsibility (CSR) can be the result of personal values and beliefs of few managers despite the risk associated with it including commercial and subsequent personal outcomes (Hemingway and Maclagan, 2004). The potential research questions that were formed are:

RQ3: *What value factors influence the decision-making process of managers when adopting Green IT/IS?*

RQ4: *How do the managers’ value orientation moderate the weights of the antecedents of managers’ behavior towards the adoption of Green IT/IS?*

Addressing these questions is important because values have an important influence on organizational behavior (Grojean et al., 2004), and influence behavioral choices as individuals are motivated to act in a manner that is consistent with matters that are of value to them (Schwartz et al., 2012, Schwartz, 1992). For complex problems such as, climate change and environmental sustainability, it is essential to also investigate the influence of personal values on behavioral intention to practice Green IT/IS initiatives.

Demography Characteristics. Based on the UET, observable (or socio-demographic) characteristics are the ones that a manager brings to an administrative situation. Examples of such characteristics are age, working experience in the current position, education, and socioeconomic roots (Hambrick, 2007).

In the IS literature it has already been proven that socio-demographic variables are critical in understanding how individuals make decisions regarding the adoption of technologies (Venkatesh et al., 2003) such as, healthcare robots adoption (Alaiad and Zhou, 2015), e-government adoption (Dwivedi and Williams, 2008), corporate web-service adoption (Kim and Olfman, 2011), satisfaction and loyalty (Seiler et al., 2013), and broadband adoption (Dwivedi and Williams, 2008). In the business ethics literature, the importance of these variables on individuals’ ethical decision making has already been proven (Loe et al., 2000, O’Fallon and Butterfield, 2005, Lehnert et al., 2014, Craft, 2013, Ford and Richardson, 1994). In the literature it has been identified that people who behave more ethically and are more ecologically responsible are female (Abeliotis et al., 2010, Cagle and Baucus, 2006, Sánchez et al., 2015), older (Brouthers et al., 2008, Krambia-Kapardis and Zopiatis, 2008, Eweje and Brunton, 2010), and well-educated (do Paço et al., 2009, Sánchez et al., 2015). The link between socio-demographic characteristics and proenvironmental behaviors have been

explored by several researchers in the literature (Shen and Saijo, 2008). As reported in the study by Park et al. (2012), the previous results related to the relationship between socio-demographic variables and environmental behaviors can be summarized as follows: (1) females are more ecologically concern than males, or there is no significant relationship between gender and environmental concern, (2) there is a positive correlation among the education level and environmental behaviors, and (3) with regard to age previous studies reported conflicting results (the relationship may be negative, positive, or insignificant).

In the literature the factors affecting ethical decision making are numerous. Musbah (2010), identified over forty variables affecting ethical decision making processes in the literature that were divided in three groups: personal variables, organizational variables, and ethical issues variables.

Important personal variables were identified as age, gender, educational level, and working experience. Choosing only these variables from the vast range of factors introduced in the literature is mainly for several reasons. Firstly, within individual variables, factors such as, age and gender have been reported more than any other variable in business ethics literature (O'Fallon and Butterfield, 2005). However, very limited research has investigated the influence of these factors on ethical

decision making within developing countries (Al-Khatib et al., 1995, Shafer, 2008). Furthermore, variables such as, age, gender, working experience, and educational level can be collected easily from the participants. Secondly, as asserted by Musbah (2010), factors such as, the levels of education and working experience have been given little attention in business ethics literature.

In the reviewed Green IS/IT adoption literature the only study that investigated the influence of personal variables is a study paper by Molla et al. (2014). Hence, there is a great opportunity for future researchers to study the moderating influence of demography characteristics in their studies as well. Hence, the following potential research questions are emerged:

RQ5: *What is the moderating influence of managers' age on their decision-making process towards Green IT/IS adoption?*

RQ6: *What is the moderating influence of managers' gender on their decision-making process towards Green IT/IS adoption?*

RQ7: *What is the moderating influence of managers' education level on their decision-making process towards Green IT/IS adoption?*

RQ8: *What is the moderating influence of managers' working experience on their decision-making process towards Green IT/IS adoption?*

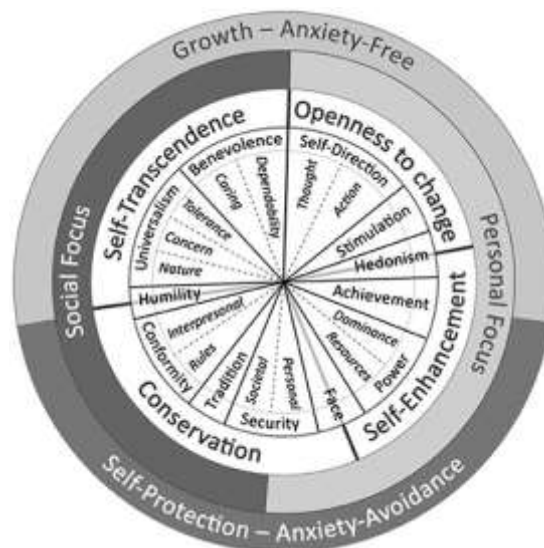


Fig. 11. Schwartz's refined theory of basic value (Schwartz et al., 2012)

6. Conclusion

Green IT/IS is an emerging topic that is of immense importance within the IS research stream since 2007. What has also been found in this paper is that IS researchers have addressed issues related to environmental sustainability using IT and IS applications.

A systematic literature review summarized the status quo of research on Green IT/IS adoption within organizations. Also, employed in this study was an analysis of some defined research questions. This study contributes to research in several ways. First, it provides a systematic

review of existing research in Green IT/IS where 237 significant contributions were identified. Of these there were 67 journal articles, and 170 conference proceedings. Of the 237 studies, 34 articles discussed the adoption of Green IT/IS using diverse theoretical lens. The contributions were also systematically categorized, which provided the current status of the emergent research fields. From this identification, researchers considering researching the Green IT/IS can be proffered future perspectives. What was also important for researchers is an understanding of the issues of research that has been completed, the applied theoretical lens, employed research methods, and regions of the globe that research has been, or

not been undertaken. Once again, by pursuing such a perspective, some future directions have been proposed using upper echelon theory.

To conclude, a systematic literature review such as that provided in this study and application of the guidelines proposed by Kitchenham (2004), assists in providing rigor to research. We believe that the implication of this study for academia is an introduction and awareness of issues associated with the Green IS/IT adoption research area.

Appendix

Table 1

Reviewed studies categorized based on their focus of study

Category	Studies
Initiation	Mithas and Khuntia (2010), Tan et al. (2011), Fradley et al. (2012), Hedman et al. (2012), Mann et al. (2009), Sayeed and Gill (2009), Kim and Ko (2010), Osch and Avital (2010), Jung et al. (2011), Corbett (2012), Corley et al. (2012), Lei and Ngai (2012), Thies and Stanoevska-Slabeva (2012), Grant and Appan (2014), Grant and Marshburn (2014), Elliot and Binney (2008), Sarkar and Young (2009), Cooper and Molla (2012), Opitz et al. (2014c), Opitz et al. (2014b), Angeles and Fredericton (2015), Sacchero and Molla (2009), Ijab et al. (2011), Butler and Daly (2009), Schmidt and Kolbe (2011), Thongmak (2012), Molla and Cooper (2014), Harmon et al. (2010), Molla et al. (2011), Kuo and Dick (2009), Thomas et al. (2015), Benitez-Amado et al. (2010), Bose and Luo (2011), Molla (2009a), Cooper and Molla (2014), Butler (2011a), Nagy-Rothengass and Schouppe (2007), Rapp et al. (2011), Herzog et al. (2013), Kramer and Jamous (2013), Masele and Gómez (2013), Fors and Lennerfors (2013), Chasin (2014)
Benefit	Corbett (2010), Thambusamy and Salam (2010), Curry and Donnellan (2012), Dorsch and Häckel (2012), Hovorka and Corbett (2012), Nishant et al. (2012), Hasan et al. (2009), Brooks et al. (2010), Hasan and Dwyer (2010), Iacobelli et al. (2010), McLaren et al. (2010), Ruch et al. (2011), Schiller and Merhout (2011), Vazquez et al. (2011), Yim (2011), Ryoo et al. (2011), Califf et al. (2012), Simmonds and Bhattacharjee (2012), Stolze et al. (2012), Strueker and Dinther (2012), Ijab et al. (2012), Brandt (2013), Erskine and Füstös (2013), Grimm et al. (2013), Loeser (2013), Schmidt and Busse (2013), Schödwell et al. (2013), Tushi et al. (2014), Seidel et al. (2015), Elliot (2007), Vykoukal (2010), Ijab et al. (2010), McGibbon and Sewchurran (2011), Nishant et al. (2011), Elliot and Lavarack (2012), Nishant (2012), Nishant et al. (2013a), Nishant et al. (2013b), Brauer et al. (2015), Molla et al. (2008), Tenhunen and Penttinen (2010), Vykoukal (2010), Butler and Hackney (2012), Scott et al. (2012), Zhang (2012), Butler and Hackney (2015), Wati and Koo (2010), Rogers et al. (2013), Opitz et al. (2014a), Melville (2010), Watson et al. (2010), Elliot (2011), Looock et al. (2013), Malhotra et al. (2013), Seidel et al. (2013), Corbett (2013a), Dedrick (2010), Pernici et al. (2012), Brocke et al. (2013), Seidel et al. (2014), Wang et al. (2015), Schmidt et al. (2011), Vykoukal et al. (2011), Sarkis et al. (2013), Corbett (2013b), Hertel and Wiesent (2013), Berthon and Donnellan (2011), Bengtsson and Ågerfalk (2011), Abdul Rahim and Abdul Rahman (2013), Fairweather (2011), Hutton (2011), Jeremy et al. (2013), Chen et al. (2008), Jenkin et al. (2011), Joumaa and Kadry (2012), Ardito and Morisio (2014), Arnfalk et al. (2016), Green Jr et al. (2016), Hilty (2007), Lukacs (2008), Abenius (2009), Melcher (2009), Leiner and Stoll-Kleemann (2009), Lukács (2009), Perl-Vorbach (2009), Dornheim and Moede (2012), Hintemann et al. (2014), Rivera et al. (2015), Kamilaris et al. (2015), Borges (2015), Williams et al. (2013), Sedlacko et al. (2014), Cappiello et al. (2014), Batchelor et al. (2014), Hankel (2014), Rivera et al. (2015), Kamilaris et al. (2015), Borges (2015), Salman et al. (2016), Coroama and Höjer (2016), Hintemann and Clausen (2016), Rizvi et al. (2007), Skouloudis et al. (2009), Hyršlová et al. (2013)

This research can also assist researchers by identifying areas where advancements can and should occur.

Acknowledgment

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Table 1

Reviewed studies categorized based on their focus of study

Category	Studies
Approach and strategy	Loock et al. (2011), Oakley and Salam (2011), Baeriswyl et al. (2011), Loeser et al. (2012), Loock et al. (2012), Nanath and Pillai (2012), Mohrenfels and Klapper (2012), Watson et al. (2012), Brandt et al. (2013), Wacker et al. (2014), Flüchter and Wortmann (2014), Stindt et al. (2014), Oppong-Tawiah et al. (2014), Valogianni et al. (2014), Brandt (2014), Corbett et al. (2010), Lee et al. (2011), Loeser et al. (2011), Flath et al. (2012), Goetzinger et al. (2012), Opitz et al. (2012), Qiu et al. (2012), Rubin and Rubin (2012), Krogstie et al. (2013), Moeller et al. (2013), Hilpert et al. (2014b), Pye and Rai (2014), Nomani and Cater-Steel (2014), Abraham and Mohan (2015), Ekman et al. (2015), Lee and Casalegno (2010), Ereik et al. (2011), Chowdhury et al. (2013), Molla (2009b), Butler (2011b), Curry et al. (2011), Bradshaw and Donnellan (2013), Mustaquim and Nyström (2014), Stiel (2014), Hilpert et al. (2014a), Zampou et al. (2015), Nuss (2015), Degirmenci et al. (2015), Frehe (2015), Schmidt et al. (2009), Wati and Koo (2011), Loeser et al. (2013), Reiter et al. (2014), Lubbecke et al. (2015), Cater-Steel and Tan (2010), Parker et al. (2011), Parker et al. (2014), Bai and Sarkis (2013), Ryoo and Koo (2013), Gholami et al. (2013), Bai and Sarkis (2013), Huang (2009), Pitt et al. (2011), Chou (2013), Chou and Chou (2012), Uddin and Rahman (2012), Faucheux and Nicolai (2011), Zhang and Xie (2015), Strüker et al. (2013), Schmidt et al. (2010b), Ranjit and Xin (2012), Gholami et al. (2016), Arnfalk et al. (2016), Shevchuk and Oinas-Kukkonen (2016), Degirmenci and Recker (2016), Jagani et al. (2016), Swist and Kuswara (2016), Stein and Flath (2016), Watts (2016), Schrieck et al. (2016), Brendel et al. (2016), Chou and Chen (2016), Brauer et al. (2016a), Schweiger (2016), Kozlovskiy et al. (2016), Zampou et al. (2016), Pimpisut et al. (2007), Naumann et al. (2008), Süpke et al. (2009), Page et al. (2009), de Jong (2009), Ganoulis (2009), Scharl (2009), Ziep et al. (2010), Dick and Naumann (2010), Davila et al. (2012), Álvarez (2012), Dick et al. (2012), Kern et al. (2013a), Schlachter et al. (2013a), Giesen (2014), Hankel et al. (2014), Howard et al. (2014), Zita et al. (2014), Xavier et al. (2014), Gottschalk et al. (2014), Strokova et al. (2014), Filler et al. (2014), Lundfall et al. (2015), Arushanyan et al. (2015), Blöchle et al. (2013), Kern et al. (2013b), Koçak et al. (2013), Grosskop and Visser (2013), Chinenyeze et al. (2014), Henriksson et al. (2014), Alinikula et al. (2014), Kalaitzoglou et al. (2014), Lundfall et al. (2015), Arushanyan et al. (2015), Kramers et al. (2016), Svenfelt and Zapico (2016), Ringenson and Höjer (2016), Sabet and Easterbrook (2016), Quinn (2007), Léger et al. (2007), Lubos and Jana (2007), Rickerby et al. (2009), Petry and Hepting (2009), Denzer et al. (2011), Aitkenhead et al. (2013), Schlachter et al. (2013b), Bezáková (2013), Kučera and University (2013), Jolma et al. (2015), Camargo et al. (2015)
Adoption	Chen et al. (2009), Wunderlich et al. (2013), Busse et al. (2013), Busse et al. (2013), Schmidt et al. (2010a), Seidel et al. (2010), Nedbal et al. (2011), Kranz and Picot (2012), Mancha et al. (2014), Simmonds and Bhattacharjee (2014), Pollard (2015), Deng and Ji (2015), Molla and Abareshi (2011), Koo et al. (2013), Lei and Ngai (2013a), Lei and Ngai (2013b), Lin et al. (2013), Yang et al. (2013), Lei and Ngai (2014), Zheng (2014), Dalvi Esfahani et al. (2015), Molla (2008), Karanasios et al. (2010), Kranz and Picot (2011), Wati and Koo (2012), Chen et al. (2011a), Gholami et al. (2013), Koo et al. (2015), Coffey et al. (2013), Chow and Chen (2009), Molla and Abareshi (2012), Molla et al. (2014), Koo and Chung (2014), Akman and Mishra (2015), Cai et al. (2013), Mishra et al. (2014), Chen et al. (2016), Dalvi-Esfahani et al. (2017), Bohas and Poussing (2016), Brauer et al. (2016b), Yang et al. (2016), Lossin (2016), Masele and Marx Gómez (2012), Johnson et al. (2014), Bookhagen et al. (2013)

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