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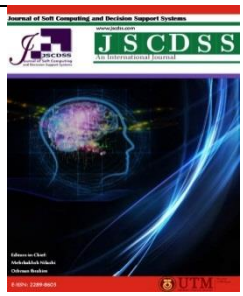

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Green Information Technology Adoption: A Systematic Literature Review

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Abstract

To tackle the current environmental problems, the adoption of Green IT is considered as a reasonable effort for organizations which can improve their economic performance. To investigate the previous studies that have been done on Green IT, a Systematic Literature Review (SLR) was undertaken to identify, evaluate and interpret all the existing research studies related to the specific research topic, phenomenon of interest, or study area. The data was collected from the primary studies published during the year 2010 to 2019 in the form of the conference, journals, and other online sources. A total of 135 primary studies were included based on the defined inclusion, exclusion, and quality criteria. This research summarises and organizes the existing literature published related to Green IT based on the defined keywords and research question. This will provide a roadmap to guide future studies on Green IT and highlight directions for the successful implementation of Green IT in organizations.

Keywords: Green IT, Sustainability, Systematic literature review, Organizations, Adoption.

1. Introduction

The Green IT concept is affected by and intertwined with the concepts of sustainability, ecological sustainability, information systems, and information technology. In order to understand how IT contributes to environmental sustainability, it would be better to first elaborate on their related concepts. Then, the terms Green IT and Green IS are conceptualized. According to Mulvihill and Milann (2007), the concept of sustainability is considered as complex and not entirely understood or established. The definition of sustainable development is the improvement that performs the requirements of the present world, without compromising the capability of the next generations to fulfill their requirements (Brundtland, 1987). Economic sustainability, which is the generation of profits, is followed by many firms, especially the larger firms. To improve the competitiveness, market share and profitability, some firms concentrate solely on economic sustainability, which can lead to only short-term success. In order to have long-term success, the sustainability of the economic, social and environmental capital should be considered by organizations (Dyllick and Hockerts, 2002).

The Triple Bottom Line (TBL) refers to balancing of social responsibility and environmental obligations with the economic profitability which is considered the main goal of organizations (Elkington, 1997). Indeed, the long-term profitability and continuing existence of organizations are best aided by balancing them with environmental and social aims (Porter and Kramer, 2006; Hart, Milstein and Ruckelshaus, 2003). Fig. 1 shows the TBL perspective of sustainability, which has been adopted to consider organizational sustainability to include the natural, social, environmental and economic performance components (Elkington, 2004).

However, some organizations still focus on economic sustainability, which is a single bottom line measure (Chen, Watson, and Karahanna, 2009; Unhelkar, 2012; Chen et al., 2008). Organizations are expected to engage in business undertakings with sustainable approaches beyond mere economic interests, in order to gain long term sustainability (Fadhilah and Ramayah, 2012).

Thus, the IT-based environmental greening is considered as a partial solution to this issue and the adoption of Green IT is an important step for these organizations (Lei and Ngai, 2014). Green Information Technology (IT) is defined

as: "systematic application of ecological-sustainability criteria, such as pollution prevention, product stewardship, and use of clean technologies, for the creation, sourcing, use, and disposal of IT technical infrastructure, as well as within the human and managerial components of the IT infrastructure" (Molla et al., 2011). The literature reveals that several articles have been published related to Green IT adoption in the organizational and level (Yu and Wang, 2017; Zheng, 2014; Asadi, Hussin and Dahlan, 2017). This research work investigated the potential benefits and advantages of adopting Green IT in organizations.

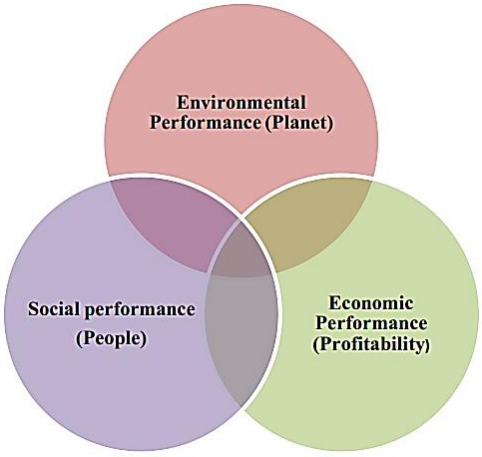

Fig. 1.The triple bottom line of sustainability

Prior scholars asserted that Green IT is considered as emerging research area (Nanath and R Radhakrishna, 2012; Asadi and Dahlan, 2017; Tushi, 2015; Asadi, Hussin and Dahlan, 2018; Asadi, Hussin and Saedi, 2016; Asadi *et al.*, 2015). Therefore, it would be ideal to have a comprehensive and detailed study of the available literature for the purpose of the Green IT and their potential factors for adoption in the organizations in the past decade. This research summarises and organizes the existing literature published related to Green IT based on the defined keywords and research question. To achieve the research objectives, the following research questions were proposed:

RQ1: What are the adopted theoretical frameworks by previous researchers for Green IT adoption?
RQ2: What are the influential factors for Green IT adoption in the organization?

The remaining of the paper is organized as follows. In Section 2, the applied methodology is elaborated. Section 3 deliberates the research process which is based on the guidelines for conducting systematic literature reviews. Results and discussions along with the answers of the research questions are discussed in Section 4. Finally, the paper is concluded in Section 5.

2. Review method

The proposed study applied systematic literature review (SLR0 approach was recommended by (Kitchenham and Charters, 2007) and followed the (Asadi *et al.*, 2019; Elaish *et al.*, 2017) guideline to answer the aforementioned research questions. Kitchenham and Charters (2007) asserted that the ''systematic literature review provides a means for the evaluation and interpretation of the available research which is pertinent to a specific topic area, research question, or a phenomenon of interest". Based on the Kitchenham and Charters (2007) three phases, planning, conducting, and reporting should compromise for conducting SLR. Each phase also has particular activity including: (1) identifying the research question, (2) developing a review protocol, (3) identifying the inclusion and the exclusion criteria, (4) searching for strategies and studying the selection procedure, (5) performing a quality assessment process, and (6) carrying out the data extraction and synthesis. The following sections described each activity in detail.

2.1 Review protocol

Defining review protocol is considered the initial step for conducting SLR which guide the study and deliver a clear direction for the research (Kitchenham and Charters, 2007). In addition, applying predefined review protocol can decrease the possibility of the bias in the research (Kitchenham, 2004). The main stages in review protocol comprise: "including the research setting, the search strategy, the review questions, the criteria for the review selection process, the elements of quality assessment, the data extraction method, and the synthesis of the extracted data" (Kitchenham and Charters, 2007). The review questions were described in the previous section, while subsequent sections compromise future descriptions of the listed stages. Applied review protocol for this study is shown in Fig. 2.

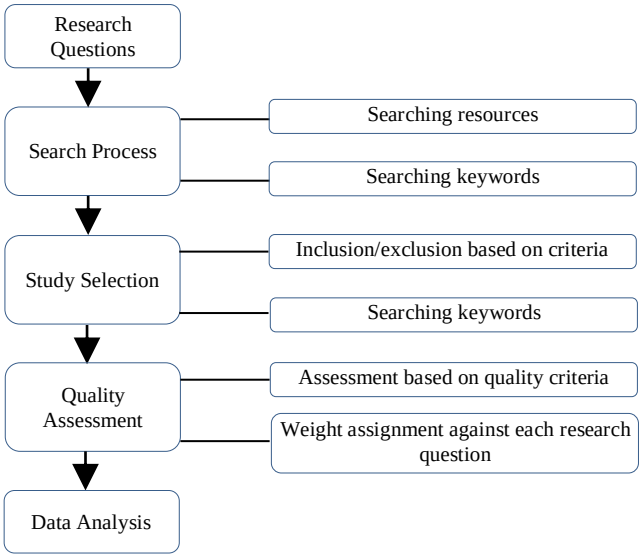

Fig. 2. Review Protocol

2.2 Inclusion and exclusion criteria

The aim of using Inclusion and exclusion criteria is to ensure that all the selected papers for the SLR are more

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relevant. As the focus of this study is on Green IT adoption and exploring factors which influence its adoption, therefore, this study considered articles which published in MIS ranked journal and conferences and also published in the English language between 2010 and 2019. This time "2010" was considered for the researchers as initial date of research on Green IT. Because MIS Quarterly in 2010 published special issue on ''Organisational sustainability and information systems" after that scholars start to do more research on it before this time the role of Information Systems (IS) and IT was ignored. Table 1 explains the inclusion and exclusion criteria of this study.

Table 1
The inclusion and exclusion criteria

Inclusion	Exclusion
The paper published in the year 2010-2019.	The papers not in the range
The article is written in English	Not in English
The article answers the defined research questions	Not related to the defined research questions

2.3 Search strategy

To conduct a systematic literature review, one should plan a formal search process as it is very necessary to search each individual source. According to Bandara, Miskon and Fielt (2011) study a search strategy "significantly contributes to the methodical extraction of papers in a literature review. It is important to determine what terms one will look for and use in the searching, to extract the relevant papers and determine how these will be specified during the search". In this study for conducting SLR, an appropriate search has been done to find the relevant materials published in the most dominant and known journals, conference proceedings, and other online materials. The following keywords were used for searching the relevant articles: ''Green IT", ''Sustainability", "Green IT adoption factors" and ''Green IT adoption". Following libraries (with their website link) were searched for the studies related to the research:

- Institute of Electrical and Electronics Engineers (IEEE)
- ScienceDirect
- SpringerLink
- Taylor and Francis Online
- Wiley Online Library

2.4 Study selection process

The main goal of the selection process is identifying and selecting relevant articled for the SLR. Based on the defined keywords which mentioned above, in the initial stage, 230 research articles were extracted from the automatic search. After deleting 40 duplicated articles by Mendeley references management tool,190 articles have remained. Afterward, inclusion and exclusion criteria were applied for each article. In this stage, 48 paper was eliminated. In this step, we excluded those articles were not related to the research area. In addition, a manual search for each reference of articles also was applied and 17 articles were found based on manual search. Then Quality Assessment (QA) was applied for the total remaining paper and 22 articles were eliminated also in this step. Therefore, 135 articles were extracted as the final and primary studies.

2.5 Quality assessment

For assessing the quality of the extracted papers as a primary study the QA was employed. All of the articles were reviewed and the quality of the papers with respect to each research question was assessed. The QA was based on the quality instruments, which included the checklist of the factors and the questions which must be used for every report (Kitchenham and Charters, 2007; Bandara et al., 2011). Following is the Quality Criteria (QR) defined against each research question.

QR1: The paper provides a clear description of Green IT.
QR2: The paper provides a detail of the work done since the year 2010 till August 2019.
QR3: The paper provides details of the research methodology.
QR4: The paper emphasizes the clear statement regarding the objectives of the study.

The weights were assigned in the following manner.

- **2**, to those articles which satisfied the criteria;
- **1**, to those papers which satisfied a criterion partially;
- **0**, if any paper did not satisfy the criteria.

Based on Kitchenham and Charters (2007) "studies that score 5 or above, will be considered high, while if they score 4, they will be considered medium, and if it is below 4, considered low". Therefore, in this study 22 articles were eliminated after applying QA. The remaining studies are considered high score based on QA criteria. Hence, the final articles included in the SLR is 135 articles.

3. Data extraction and synthesis

Data extraction form was designed for recording accurately all the information from 135 articles. In this step, Mendeley and Microsoft Excel spreadsheets were used for reading each study carefully and extracting all the required data from the articles. For data extraction

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following column were considered: study ID, authors, study title, date of publication, source, research theme, the topic addressed, and theory. Table 2 is shown the explanation of each element.

Table 2
Data extraction of primary studies.

Entractes Data	Explanation
Study ID	"Unique identity for the paper"
Authors	"Names of all the authors"
Study Title	"The name of the paper which appear in the searching stage"
Publication Date	"The year of publishing the paper (2010–2019)"
Source	"E.g. conference proceeding, journal"
Theory	"Theory the paper adopted, e.g. NAT, RBV, etc."

3.1 Publication sources overview

In this study in total 135 articles were selected as a primary study. Most of the extracted paper was published in MIS leading journal and conferences. Out of these extracted articles, 84 were conferences papers and 51 journal papers. As shown in Fig. 3, the total selected papers are categorized based on their year journal and conferences type. The figure revealed that study on Green IT has been gradually increased by a year. In addition, between 2010 and 2011 there was the growth of publications in Green IT topic.

3.2 Temporal view of the publication

As discussed above the time period of 2010 and 2019 was selected for this review paper. Fig. 4 shows the distributions of the selected articles in the defined time period. Fig. 4 represents the rise in the number of publications for Green IT in the selected year range. Moreover, it is clear from the figure that the highest number of publications is between 2010 and 2011.

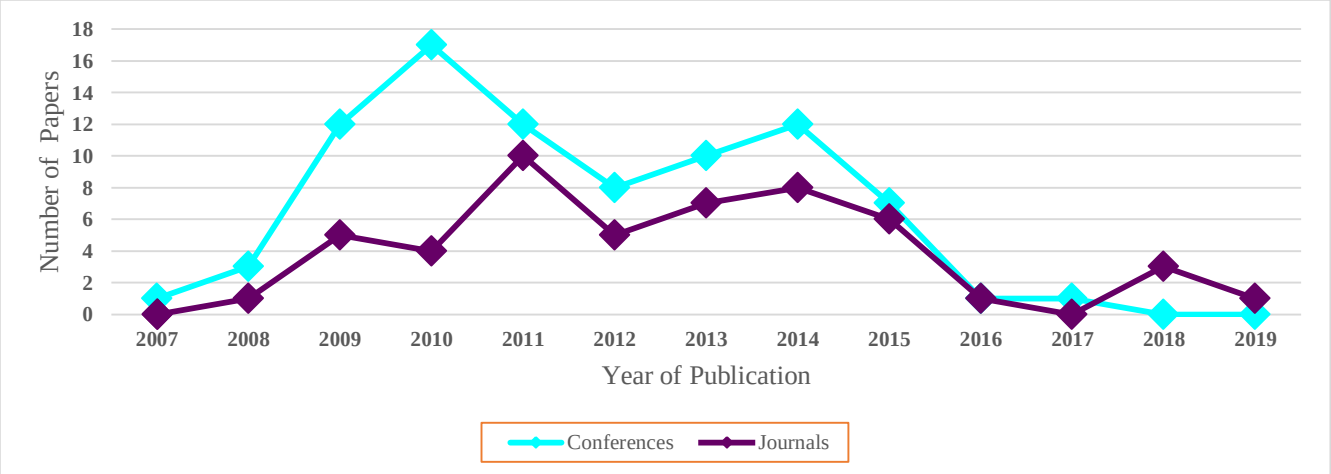

Fig. 3. Journal and conference publications on Green IT

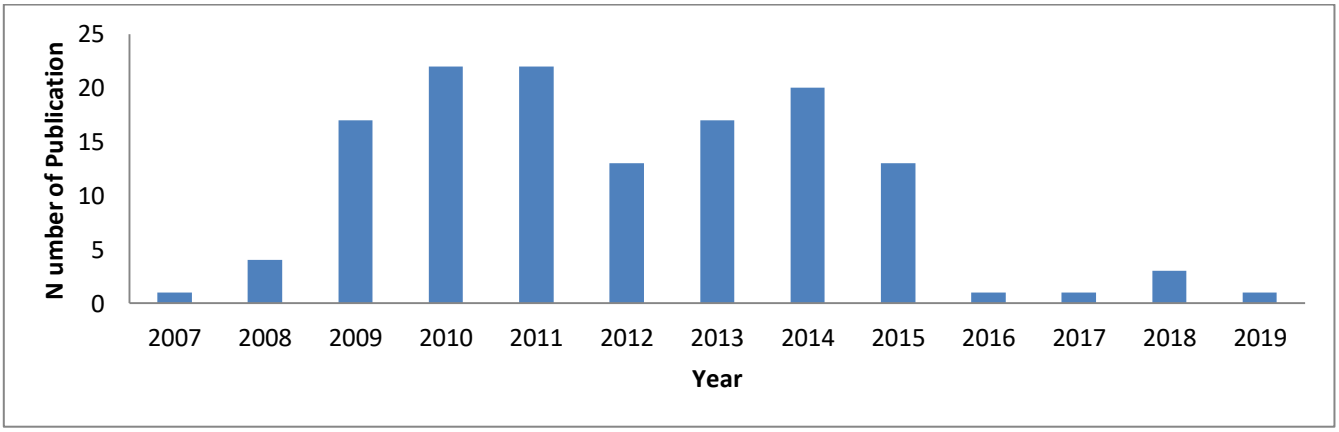

Fig. 4. Temporal view of publications

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4. Research question results

RQ1: What are the adopted theoretical frameworks by previous researchers for Green IT adoption?

Because Green IT has many facets, numerous theoretical model and framework have been used by scholars. Several theories have been employed in the organizational and individual level. As depicted in Fig. 5, "institutional theory" was used most by the researchers at the organizational level. The institutional theory which was originated by Scott (1995) identifies how organizations adapt to institutional change through three different mechanisms "mimetic, normative, and coercive isomorphism" (Chen *et al.*, 2011). This theory also underlines the significance of the institutional environment for shaping organizational actions and structure (Scott, 2001). For example, the study conducted by Chen et al. (2011) applied institutional theory to provide empirical support for the complementary effects between mimetic and coercive pressures in driving the adoption of IT and IS-based product stewardship by organizations. Sarkar and Young (2009) also utilized institutional theory to understand the drivers of corporate environmentalism and to analyze how the external social pressure the organization's behaviours and policy-making.

Natural Resource-Based View (NRBV) theory is considered as the second most applied theory by previous studies. Hart (1995) proposed a natural-resource-based view of the firm by integrating the natural environment into the resource-based view. An organization 's competitive advantage is built upon its capabilities to engage in green economic activities.

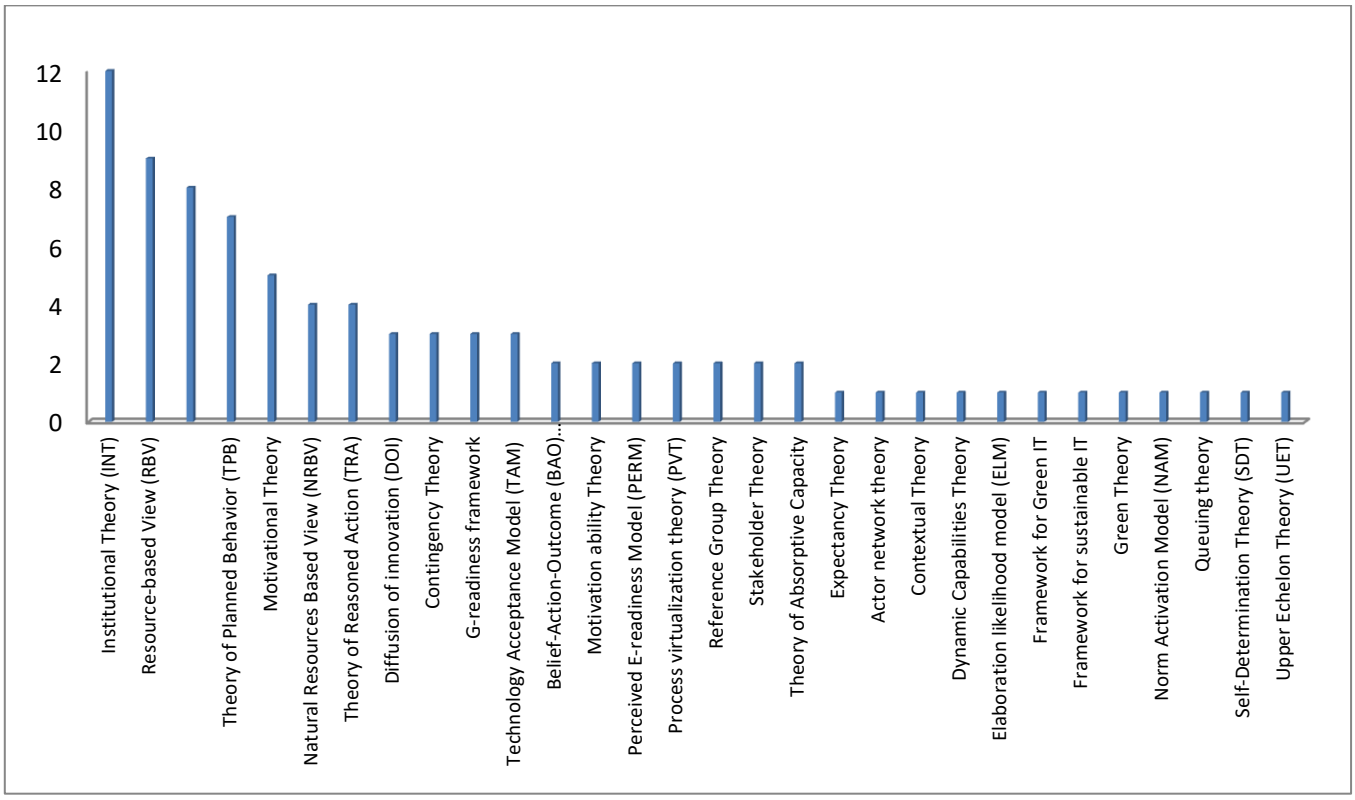

Fig. 5. Applied theoretical model and framework by previous studies

The third most applied theory by previous literature was a technological, organizational, and environmental theory (TOE). Tornatzky et al. (1990) proposed the TOE framework to explain the organization's adoption of technological innovation. According to this theory, the organization's adoption and implementation of technological innovation were affected by three groups of factors: technological, organizational, and environmental factors (Khor et al., 2015).

RQ2: What are the influential factors for Green IT adoption in the organization?

Previous studies, both conceptual and empirical, have addressed green IT adoption from a number of perspectives. Various terminologies have been used, e.g., green IT adoption (Asadi *et al.*, 2015; Asadi, Hussin and Dahlan, 2018; Asadi, Hussin and Saedi, 2016; Chen, Watson and Karahanna, 2009) green IT initiative/initialization (Simmonds and Bhattacherjee, 2014; Bose and Luo, 2011), extent of green IT (Kuo and Dick, 2010; Nils-Holger Schmidt et al., 2010) and intention for green IT adoption (Lei and Ngai, 2014). The factors identified in previous studies can be viewed, for most cases, as antecedents of green IT adoption factors. Since the objective of this study is to provide a broader study on

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Green IT adoption are considered. Table 1 in Appendix A presents a summary of the review of extant predictors of green IT adoption identified in previous studies.

5. Conclusions

A systematic literature review was conducted on publication to establish the current understanding of Green IT which has emerged as new technology and gained increasing attention from the organizational and individual perspectives. However, in some disciplines the body of knowledge for Green IT is still limited. Therefore, a better consideration of the multifaceted nature of Green IT is required to create strategies in promoting Green IT adoption in organizations. Fig. 5 depicts the most commonly applied theories in Green IT adoption within the organizations, which shows that the level of analysis for the majority of studies is at the organizational level. In addition to the organizational factors in Green IT, the individual drivers and actions need to be identified and understood (Hasan and Dwyer, 2010). However, most of the prior studies focused on the organizational level and the understanding of the individual level remains inadequate. Among the adoption studies of Green IT, few of them studied the decision maker's intention to adopt Green IT in organizations. More specifically, although there is a body of research investigating the adoption of Green IT in organizations, such research takes place primarily at the mezzo level where the locus of responsibility is the organization itself. Moreover, the number of studies on how the organizational factors influence the intention and behaviour of individuals toward Green IT/IS adoption is limited (Gholami et al., 2013). In the field of IS, several studies have conceptually and empirically addressed Green IT adoption from diverse perspectives.

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Appendix A

Table 1

Summary of Factors from Previous Studies in Green IT Adoption

Author(s)	Green IT Studies	Theories/Models Used	Factors							
			Attitude	Competitive Advantages	Subjective Norm	Personal Norm	Ascription of Responsibility	Awareness of Consequences	Perceived Behavioral Control	Managerial Interpretation
(Mishra, Akman and Mishra, 2014)	Behaviors towards GIT among IT professionals	Theory of Reasoned Action	√		√					
(Mancha, Muniz and Yoder, 2014)	Predicting green behavioral intentions	Theory of Planned Behavior	√		√				√	
(Akman and Mishra, 2015)	Investigating the existence of diversity among public- and private-sector establishments in terms of the adoption of GIT practices	Technology Acceptance Model	√		√					
(Lei and Ngai, 2014)	Managerial Intention to Green IT Adoption	Norm Activation Model		√		√				√
(Pollard, 2015)	Computer Energy Saving Behavioral Intention and Use at Work	Theory of Planned Behavior	√		√				√	
(Dalvi-Esfahani, Ramayah and Nilashi, 2017)	Upper echelons' behavioral drivers of Green IT adoption	Upper Echelon Theory	√		√	√	√	√		
(Lei and Ngai, 2013)	Green Information Technologies Adoption: A Managerial Perspective	-		√						√

Table 1

Summary of Factors from Previous Studies in Green IT Adoption (Cont.)

Author(s)	Green IT Studies	Theories/Models Used	Attitude	Competitive Advantages	Subjective Norm	Personal Norm	Ascription of Responsibility	Awareness of Consequences	Perceived Behavioral Control	Managerial Interpretation
(Koo and Chung, 2014)	Smart Green IT adoption behavior	Self-determination theory	√		√					
(du Buisson and Naidoo, 2014)	Green computing behavior among IT workers	Theory of Planned Behavior	√		√				√	
(Koo, Chung and Lee, 2013)	Determinants of behavior intention to use green IT device	Motivation and Reference group Theories			√					
(Akman and Mishra, 2014)	IT professionals' intentions for Green Information Technology practices	Theory of Planned Behavior			√				√	
(Chow and Chen, 2009)	IT users 'perception of their intended belief and actual Green Computing behavior	Theory of Reasoned Action and Theory of Planned behavior	√		√				√	
(Molla, Abareshi and Cooper, 2014)	Green IT beliefs and pro-environmental IT practices	Belief-Action-Outcome Framework	√							
(Esfahani *et al.*, 2015)	Practicing Green Information Technology	Elaboration-likelihood model	√							

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