sustainability

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Organizational Green IT Adoption: Concept and Evidence

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Received: 24 June 2015; Accepted: 14 December 2015; Published: 18 December 2015
Academic Editors: Isabel Ramos and Rui Dinis Sousa

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Abstract: Green IT has emerged as an important research topic in information systems and in other areas, such as business sustainability management. Some progress has been made in our understandings of green IT in a wide area of research topics, ranging from the green IT definition to the motivation for adopting green IT by organizations. This paper provides a holistic review and explanation of why organizations adopt green IT. Based on an extensive review of extant studies and a broad theoretical foundation, the paper presents a theoretical framework on organizational green IT adoption (OGITA). For researchers, the study provides a comprehensive review of previous green IT adoption studies and a roadmap for future research. For practitioners, the study provides managers and policy makers a systematic analytical framework in guiding their business decisions.

Keywords: green IT adoption; sustainable competitive advantage; content analysis

1. Introduction

Sustainable development and green growth have been recognized by organizations to be an important strategic initiative when many are under increasing social, economic and regulatory pressures [1–3] to compete in the global market. As such, many organizations are searching for tools that provide support for a business strategy that encompasses social, economic and environmental objectives (*i.e.*, the triple bottom line [4–6]). Green IT (defined in Section 2), because of its important role in energy consumption and in monitoring and coordinating business activities, has become an emerging topic and has received wide attention from both practitioners and scholars [7]. According to a report that surveyed 426 companies in North America and 1052 companies worldwide, 86% believed that it is imperative to implement green IT initiatives [8]. The emergence of green IT promises organizations the benefits of reducing power consumption and carbon emissions, improving operation system performance and increasing interaction and collaboration [9]. However, despite these benefits, it is still not clear what are the main determinants for green IT adoption by organizations.

As Brooks *et al.* [10] has proposed, in the context of the organizational level, the first of three of the most provident research questions for future green IT study is: What motivates a company to adopt green IT initiatives? Research on organizational green IT adoption has recently proliferated in Information Systems (IS) and other business disciplines, such as corporate strategy and social responsibility. However, the current studies are developed on many different theoretical perspectives that are quite fragmented and scattered. A holistic theoretical framework on green IT adoption is absent. The authors of this paper hope to shed light and provide guidance to both green IT researchers and practitioners by identifying and summarizing current studies on organizational green IT adoption and developing and proposing an integrative theoretical framework to explain why organizations adopt green IT. The review of current studies is intended to present researchers with an overview of previous green IT adoption studies; while the proposed framework is intended to provide researchers

with a roadmap for future research on green IT adoption and to assist managers, who currently might consider adopting green IT in their organization, with guidance in their decision making by providing them a systematic analytical framework.

The rest of this paper is organized as follows. Section 2 provides a review of existing relevant literature by focusing on the definitions of green IT and the extant predictors of organizational green IT adoption. Section 3 introduces a theoretical framework and, based on which, proposes several associated propositions. Section 4 provides insights and concluding remarks, the limitations of the paper and suggestions for future research.

2. IT and IT Application in Organizations

The impacts of IT on organizations are two-fold. On the one hand, IT is the source of environmental problems. In addition to the direct negative effects of IT manufacturing on the natural environment [11–13], the global IT industry alone was estimated to account for approximately 2% of the global carbon dioxide (CO_2) emissions [14]. On the other hand, IT is often regarded as a solution to and tool for environmental problems. It is believed that numerous IT applications, such as e-commerce, smart grids, smart buildings, digital media, virtual goods/mobility and intelligent transport systems, have a positive effect on reducing environmental pollution and carbon emissions [15]. As many have pointed out, for the IT sector, the challenge is to directly address 2% of emissions by improving energy efficiency in IT products and to directly and indirectly address the remaining 98% through innovative IT applications in other sectors [16].

2.1. Defining Green IT

Green IT has been conceptualized in many ways with a variety of terminologies and concepts [17], such as green IS [17–20], IT for green [21,22], green IS and IT [23], and environmentally-sustainable ICT [7,16]. A summary of the terminologies and their definitions is presented in Table 1.

Table 1. Green IT terminologies and definitions.

Citation	Terminology	Definition
Bose and Luo [9]	Green IT	"Green IT refers to the using of IT resources in an energy-efficient and cost-effective manner." (p. 38)
Cai *et al.* [21]	Green IT IT for Green	"Green IT is the practice of designing, manufacturing, using and disposing of computer, servers and associated subsystems efficiently and effectively with minimal or no impact on the environment, with a strong focus on improving energy efficiency and equipment utilization through steps such as designing energy efficient chips, virtualization, reducing data center energy consumption, using renewable energy to power data centers, and reducing electronic waste. IT for green is the use of information systems to enhance sustainability across the economy, with a focus on IT as a solution." (p. 3)
Chen *et al.* [23]	Green IS and IT	"Green IS & IT refers to IS & IT products (e.g., software that manages an organization's overall emissions) and practices (e.g., disposal of IT equipment in an environmentally friendly way) that aims to achieve pollution prevention, product stewardship, or sustainable development." (p. 4)
Dedrick [17]	Green IS Green IT	"Green IS refers to the use of information systems to achieve environmental objectives, while Green IT emphasizes reducing the environmental impacts of IT production and use." (p. 173)

Table 1. *Cont.*

Citation	Terminology	Definition
Elliot [7]	Environmentally sustainable ICT	"The design, production, operation and disposal of ICT and ICT-enabled products and services in a manner that is not harmful and may be positively beneficial to the environment during the course of its whole-of-life." (p. 107)
Elliot [16]	Environmental sustainability of IT	"Activities to minimize the negative impacts and maximize the positive impacts of human behavior on the environment through the design, production, application, operation, and disposal of IT and IT-enabled products and services throughout their life cycle." (p. 208)
Erek *et al.* [24]	Green IT	"Green IT is the systematic application of practices that enable the minimization of the environmental impact of IT, maximise efficiency and allow for company-wide emission reductions based on technology innovations." (p. 3)
Faucheux and Nicolaï [22]	Green IT IT for Green	"Green IT defined as IT sectors own activity and its impact on environmental efficiency. Green applications of IT or IT for green defined as the impact of IT on other sectors environmental productivity, particularly in terms of energy efficiency and carbon footprint." (p. 2021)
Jenkin *et al.* [18]	Green IT and IS	"Green IT is mainly focused on energy efficiency and equipment utilization." (p. 2) "Green IS, in contrast, refers to the design and implementation of information systems that contribute to sustainable business processes." (p. 2)
Lei and Ngai [19]	Green IS	"Green IS is defined as the IS or IT used to achieve environmental sustainability." (p. 3)
Lei and Ngai [25]	Green IT	"Green IT refers to the practices and process enabled by information systems (IS) that can enhance the economic and environmental performance of an organization." (p. 96)
Murugesan [26]	Green IT	"Green IT refers to environmentally sound IT. It's the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems . . . efficiently and effectively with minimal or no impact on the environment." (pp. 25–26)
Molla [27]	Green IT	"Green IT is an organization's ability to systematically apply environmental sustainability criteria (such as pollution prevention, product stewardship, use of clean technologies) to the design, production, sourcing, use and disposal of the IT technical infrastructure as well as within the human and managerial components of the IT infrastructure." (p. 3)
Molla and Abareshi [28]	Green IT	"Therefore, both IT hardware manufacturers and firms using IT need to apply principles of environmental sustainability, which include pollution prevention, product stewardship and sustainable development in managing IT. Green IT refers to such practices." (p. 3)
Molla, Cooper and Pittayachawan [29]	Green IT	"green IT is a systematic application of ecological-sustainability criteria (such as pollution prevention, product stewardship, use of clean technologies) to the creation, sourcing, use, and disposal of the IT technical infrastructure as well as within the IT human and managerial practices." (p. 73)

Table 1. *Cont.*

Citation	Terminology	Definition
Watson *et al.* [20]	Green IT Green IS	"In the practitioner literature, much of the current attention is devoted to "Green IT." We argue that this exclusive focus on information technologies is too narrow and should be extended to information systems, which we define as an integrated and cooperating set of people, processes, software, and information technologies to support individual, organizational, or societal goals. To the commonly used Green IT expression, we thus prefer the more encompassing Green IS one, as it incorporates a greater variety of possible initiatives to support sustainable business processes. Clearly, Green IS is inclusive of Green IT." (p. 24)

Before illustrating what green IT is, two similar terminologies need to be clarified: green IS and IT for green. For researchers studying green IT, there seems to be no consensus on the distinction between green IT and green IS. Some regard them as the same object and use them interchangeably. The difference between green IS and green IT can be traced back to the difference between IT and IS [10]. In-depth analysis of such a difference is beyond the scope of this paper. Consistent with [20], in this paper, we differentiate green IT from green IS. Another term is IT for green. Some differentiate between green IT and IT for green because they are defined based on the different notions, "IT as a problem" and "IT as a solution", respectively [21,22]. Despite the variance in these definitions, there seems to be a consensus on what green is [21,30]. "Green is associated with firms, systems, products and production processes that (1) use less energy; (2) recycle and reuse materials; (3) reduce waste, water use, and pollution; and (4) preserve natural resources" [21] (p. 2). Since IT for green and green IT share common goals for environmental sustainability, we treat IT for green as part of green IT. Therefore, in this paper, we define green IT by combining definitions of green IT and IT for green proposed by Cai, Chen and Bose [21], that is green IT is the practice of designing, manufacturing, using and disposing of computer, servers and associated subsystems efficiently and effectively with minimal or no impact on the environment, and with a strong focus on using information systems to enhance sustainability across the economy.

2.2. Organizational Green IT Adoption Predictors

Previous studies, both conceptual and empirical, addressed green IT adoption from a number of perspectives. Various terminologies had been used, e.g., green IT adoption [23,25,28,31], green IS adoption [19,32], green IT initiative/initialization [9,33], extent of green IT [34,35] and intention for green IT adoption [31,36]. Some studies used the process view and treated green IT initiation and green IT adoption differently; while, in practice, some researches distinguished between intention for green IT adoption and actual green IT adoption. Broadly speaking, although different terminologies have been used, the predictors (*i.e.*, determinants) identified in previous studies can be viewed, for most cases, as antecedents of green IT adoption. Since the objective of this paper is to provide a broader review of why green IT is adopted at the organization level, we treat all predictors identified in these studies equally and examined them thoroughly based on their research contexts. Table 2 presents a summary of the review of extant predictors of green IT adoption identified in previous studies. For each reviewed paper, the theoretical basis, type, core construct and components/definitions are examined and listed in the table.

Table 2. Extant studies of organizational green IT adoption.

Citations	Theoretical Foundations	Type	Core Constructs	Components and Definitions
Cai, Chen and Bose [21]	Porter's concept of competitive advantage; diffusion of innovation (DOI) theory	E	Political	Public concerns (+, NS): "interests of the community stakeholders and the public." (p. 4) Regulatory forces (+, NS): "influences from government and laws/regulations." (p. 4)
			Economic	Cost reduction (+, S): "a firm can obtain competitive advantage by selling products or services with the lowest cost in its industry." (p. 5) Differentiation (+, S): "a firm can use differentiation strategies to create unique features for its products or its services." (p. 5)
			Perceived complexity	Or perceived innovation complexity (−, NS), "refers to the degree to which innovation is perceived as relatively difficult to understand and use." (p. 5)
Chen *et al.* [23]	Institutional theory; natural resource-based view (NRBV)	E	Mimetic pressures (+)	Frequency-based imitation (+, NS): "mimetic pressure arises from the number of other organizations that have adopted a certain practice." (p. 5) Outcome-based imitation (+, S): "organizations are motivated to adopt a given practice because of the favorable results achieved by other adopters." (p. 5)
			Coercive pressures (+)	Imposition-based coercion (+, PS): regulations (e.g., public policy, industrial regulation). Inducement-based coercion (+, PS): "important supply chain partners often possess the power to create strong inducements for a focal organization to comply with their demands." (p. 7)
			Mimetic × coercive (+, PS)	"Between coercive and mimetic pressures, the presence of one is very likely to add to the institutional legitimacy suggested by the other. . . . Therefore, the presence of one pressure reinforces the effect of the other." (pp. 7–8)
Gholami *et al.* [32]	Belief-action-outcome framework; institutional theory	E	Macro factors (antecedents of attitude)	Coercive pressure (+, S): "pressure from regulatory bodies, suppliers, and customers." (p. 432) Mimetic pressure (+, NS): "mimetic isomorphism suggests that firms will follow leading firms who have realized benefits from being the first movers in the industry." (p. 433)
			Micro (belief factors)	Attitude (+, S): "an affective characteristic of senior managers; it measures the extent to which they are aware of and interested in Green IS." (p. 432) Consideration of future consequences (CFC) (+, S): "Individuals low in CFC, attach a high degree of importance to the immediate consequences of behavior; whereas those high in CFC attach a high degree of importance to the future consequences of behavior." (p. 432)
Kuo [34]		E	Motivational factors	Competitive pressures: "initiatives that reduce costs, generate revenues or improve efficiencies." (p. 2) External competitive pressures (NS): "arise from external market forces in the form of mimetic institutional pressures." (p. 2) Bottom line considerations (S): "comprised solely of economic drivers such as tangible cost savings from IT operations." (p. 2) Legitimation pressures: "initiatives are based on satisfying government, local community and stakeholders and complying with norms and regulations in order to avoid penalties and lessen risks." (p. 2) Normative legitimation pressures (S): "when cultural expectations press organizations to act in a legitimate way." (p. 2) Coercive legitimation pressures (NS): "when organizations are driven to act alike because of governmental laws and regulations." (p. 2) Social responsibility pressures (NS): "organizations act from 'a sense of obligation, responsibility or philanthropy rather than out of self-interest'." (p. 2)
			Organizational factors	Organizational capabilities (NS): "such as ongoing operational costs, the complexity of processes, the availability of resources and the capability of the organization to adapt." (p. 3) Management influences (S): support from senior management champion. (p. 3)
			Technological constraints (NS)	Including technological context, technology facilitation, the complexity of initiatives and the limitations posed by software, hardware and technological infrastructure.

Table 2. *Cont.*

Citations	Theoretical Foundations	Type	Core Constructs	Components and Definitions
Molla [27]; Molla and Abareshi [28]	Theories of organizational motivation; eco-sustainability	E; E	Eco-efficiency (+, S)	"Desire to improve eco-sustainability while at the same time pursuing economic objectives." (p. 8)
			Eco-effectiveness (+, S)	"Eco-sustainability motives associated with beliefs and value system of the organization out of deep concern for the natural environment and to achieve sociopolitical outcomes." (p. 8)
			Eco-responsive (+, NS)	"Desire to improve eco-sustainability either due to green opportunities or in response to actions and/or demands of competitors, customers, suppliers and market forces." (p. 8)
			Eco-legitimacy (+, PS)	"Desire to improve eco-sustainability due to political and social pressures facing a company." (p. 8)
Sarkar and Young [37]	Institutional theory; theory of reasoned action (TRA)	E	Managerial attitudes	Effective cost model (+, S): "cost reduction . . . need for such a comprehensive model establishing an explicit link between green IT initiatives and resultant cost savings." (p. 8) Awareness programs (+, S): "educate their colleagues in the organisation about the benefits of Green IT, and de-mystify misconceptions surrounding the issue." (p. 8)
			External influences	Customer requirements (+, S): "customers were keen on Green-enabled IT services as this allowed them to report on their carbon footprint in accordance with the government regulations." (p. 8) Government regulations (+, S): "Australian environmental regulatory agencies were close to mandating carbon footprint reporting schemes." (p. 7)
Schmidt *et al.* [35]	Technology acceptance model (TAM); DOI	E	Importance (+)	Corporate management (+, S): The IT department is approached frequently by the corporate management with the topic of green IT. Environmental engagement (+, S): How would you rate the environmental engagement of your enterprise? Experience (+, S): Our enterprise possesses a lot of experience with green IT.
			Uncertainty (−)	Experience (−, S): Our enterprise possesses a lot of experience with green IT. Measurement (−, S): The success of green IT is difficult/easy to measure. Standards (−, S): There are defined and generally accepted standards for green IT. Hype (+, S): Green IT is a hyped topic and is overrated. Initiative from IT staff (−, S): Did IT staff instigate the green IT initiative?
Bose and Luo [9]	Technology-Organization-Environment (TOE) framework; DOI; process virtualization theory (PVT)	C	Technological context	Sensory readiness: "the degree to which virtualization process participants are able to enjoy a full sensory experience of the process." (p. 47) Relationship readiness: "the need for process participants to interact with one another in a professional context." (p. 47) Synchronism readiness: "the degree to which the activities that make up a process need to occur quickly with minimum delay." (p. 47) Identification and control readiness: "the degree to which the process requires unique identification of process participants and the ability to exert control over/influence their behavior." (p. 47)
			Organizational context	Champion support: "a management-level person (e.g., CEO) who recognizes the usefulness of an idea to the organization and leads authority and resources for innovation throughout its development and implementation." (p. 48) Resource commitment: "the commitment of financial resources to Green IT as a proportion of total organizational resources." (p. 48) Firm size: "the number of employees in the organization." (p. 48)
			Environmental context	Regulatory support: "supportive government or state policies and/or legislation on the state-wide or national level can help organizations achieve their Green IT aims." (p. 49) Competition intensity: "the degree that the company is affected by competitors in the market." (p. 49)

Table 2. *Cont.*

Citations	Theoretical Foundations	Type	Core Constructs	Components and Definitions
Lei and Ngai [19]	Institutional theory; organizational information processing theory	C	Institutional perspective	"Mimetic pressure refers to pressure that drives an organization to imitate the actions and practices of others perceived to be similar to the organization." (p. 3) "Coercive pressure is the force that subjects an organization to comply with law and regulations." (p. 3) "Normative pressure refers to the expectations from the stakeholders in the same social network forcing the organization to take legitimate actions." (p. 4)
			Information processing theory	Environmental uncertainty: "information shortage on the environment that surrounds an organization, resulting in difficulties in predicting external changes and evaluating organizational actions." (p. 2)
			Organizational resources	"Operational slack refers to the operational resources of an organization that are unused or under-utilized." (p. 3) "Human resource slack refers to human resources that are skilled and specialized." (p. 3) "Financial slack refers to excess financial resources for the maintenance of the operations of an organization." (p. 3)
Lei and Ngai [36]	Norm activation model	C	Personal norm	"Refers to an organizational decision maker's self-set standard on the relationship between business and natural environment." (p. 4)
			Competitive advantage	"The expected level of economic and environmental benefits of Green IT adoption." (p. 5)
			Managerial interpretation (moderator)	"Managerial interpretation may serve as norm activator/de-activator. Decision makers' managerial interpretation on environmental preservation can either be interpreted as a threat or an opportunity." (p. 5)
Molla [31]	TOE framework; perceived e-readiness model (PERM)	C	Green IT context	Technological context: "Green IT is likely to flourish in organisations that have large installed IT assets." (p. 663) Organizational context: "refers to the descriptive properties of a business such as sector, size and corporate citizenship. " (p. 663) Environmental context: "the regulatory environment is a critical factor in creating the conducive and permissive environment for encouraging the use of some Green IT technologies." (p. 664)
			Green IT drivers	"Economic driver refers to the need for greater IT efficiency and the pursuit of tangible cost savings from IT operations." (p. 662) "Regulatory driver refers to the pursuit of legitimacy within the wider social context." (p. 663) "Ethical driver refers to the pursuit of socially responsible business practices and good corporate citizenship. " (p. 663)
			Green IT readiness	Perceived organizational green IT readiness: describes the awareness, commitment and resources of a firm relevant to green IT. Perceived value network green IT readiness: refers to the readiness of a firm's suppliers, competitors, investors, partners and customers for green IT. Perceived institutional green IT readiness: refers to business's assessment of the readiness of these institutional forces, which refer to both formal entities, such as government and professional associations, and informal norms and practices.
Nedbal, Wetzlinger, Auinger and Wagner [38]	TOE framework; DOI; process virtualization theory (PVT)	C	Technological context	Technical compatibility: "an innovation's compatibility with existing systems [...], including hardware and software". (p. 5) Perceived complexity: perceived difficult to use outsourcing solution. (p. 5)
			Organizational context	Top management support: same as champion support in Bose and Luo [9]. Transaction costs: "organizations weigh the internal transaction costs against the external transaction costs before they decide whether or not to keep certain business processes in-house, or to outsource the processes." (p. 6) Size: same as firm size in Bose and Luo [9].
			Environmental context	Regulatory support: same as regulatory support in Bose and Luo [9]. Competition intensity: same *as competition intensity* in Bose and Luo [9].

Table 2. *Cont.*

Citations	Theoretical Foundations	Type	Core Constructs	Components and Definitions
Simmonds and Bhattacherjee [33]	RBV; advanced model of corporate ecological responsiveness	C	Environmental	"The concern that a firm has for its social obligations and values" (p. 7), such as green IT properties (energy usage; material toxicity and recyclability), social responsibility pressures (from employees), eco-effectiveness and eco-efficiency.
			Economic/ competitiveness	"Potential for ecological responsiveness to improve long-term profitability" (p. 7), such as cost reduction, differentiation, adaptability to changing contexts and eco-efficiency.
			Legitimation	"The desire of a firm to improve the appropriateness of its actions within an established set of regulations, norms, values or beliefs" (p. 7)

Note: For the "Theoretical Foundation" column, each paper's theoretical basis, *i.e.*, theories on which the paper is based to derive its core arguments and reasoning, is listed. For paper "Type", empirical papers are identified with a letter "E", and conceptual papers are identified with a letter "C". The "±" in "Core Construct" indicates that the construct is hypothesized to be positively/negatively related to green IT adoption. The "±" sign in "Components and Definitions" indicates that the component is hypothesized to be positively/negatively related to the core constructs. "S/NS/PS" stands for the hypothesis is either supported, or not supported, or partially supported.In reviewing the current studies of green IT adoption, the following observations emerge.

First, as to the predictors of organizational green IT adoption, there is a broad list without consensus. As Table 2 shows, researchers have identified numerous predictors of green IT adoption. However, different studies have addressed green IT adoption from different perspectives, which can be revealed by the extensive and scattered theoretical foundations, and no consensus has been reached.

Second, organization- and environment-related predictors have received more attention than technology-related predictors. As to the former, top management support (or champion support, management influence, managerial attitude, managerial interpretation) has been identified to be positively related with green IT adoption by approximately half of the studies identified (see Table 2) and regulatory force (*i.e.*, imposition-based coercion, coercive pressure, government regulations) has been included by 12 (out of 14) studies as a positive predictor of green IT adoption; while, as to the later, only four studies included technology-related predictors in their research models. Among the identified predictors, although some have been tested empirically while others have not, it seems to be that no one is intrinsically better than others. For specific research, it is arguably that the choice of predictors should be made based on the research objective, the research context and the characteristics of green information technology addressed in the research.

Therefore, in spite of the studies reviewed, organizational green IT adoption is still emerging and needs to be explored further.

3. Explaining Organizational Green IT Adoption: Theories and a Research Model

Organizations may choose to adopt green IT for a number of reasons, including external and internal pressures, such as technological advancement, economic and business benefits of green IT and legal, social and environmental pressures. A number of traditional and contemporary organizational theories can be applied to explain such motives. Such theories include the diffusion of innovation theory (DOI), institutional theory, resource based view (RBV) of the firm and organizational cultural theory, among many. This section provides an explanation as to why an organization might adopt green IT and introduces the research model.

3.1. Explaining Organizational Green IT Adoption: A theoretical Perspective

3.1.1. Diffusion of Innovation Theory

Diffusion of innovation (DOI) theory [39] explains how, why and at what rate innovations spread through cultures, operating both at the individual and organizational level [40]. DOI theory has been applied and adapted in many domains, especially in technology adoption studies (e.g., [41–48]). It has been used to address how new technologies are adopted and how adoption decisions can be influenced by the perceptions of new technologies, the qualities of adopting organizations, as well as the characteristics of associated environments [9]. According to Rogers [39], diffusion is the process by which an innovation is communicated among members of a social system; during this process, the adoption rate is determined by the characteristics of the innovation perceived by the members of a social system. Rogers [39] identifies five attributes of innovations: (1) relative advantage; (2) compatibility; (3) complexity; (4) trial-ability; and (5) observability. Although Rogers's study focuses mainly on the studies of individual innovation adoption, Van de Ven [49] has argued that the attributes of innovation can also play significant roles in organizational technology adoptions.

3.1.2. Institutional Theory

First introduced in the field of sociology, institutional theory seeks to explain how organizations become homogeneous under social pressures [23]. The concept that best addresses the process of homogenization is isomorphism [23]. After its inception, the concept of isomorphism was "moved" from the society level to the organizational field level by DiMaggio and Powell [50,51]. They also categorized the isomorphism into three mechanisms (coercive isomorphism, mimetic isomorphism and normative isomorphism) through which institutional isomorphic change can occur.

Institutional theory has been applied to explain IT adoption in many studies (e.g., [51–55]). The theoretical viewpoint of institutional theory also shows promise for understanding how organizations may embrace sustainability [56]. Several studies have addressed corporate social and environmental sustainability through the lens of institutional theory [2,57]. Green IT adoption, as one step towards corporate sustainability, has been studied using institutional theory, as well [2,19,23,32]. Although institutional theory could be applied at multiple levels, in this paper, we use it to primarily capture the external pressures motivating organizations to adopt green IT.

3.1.3. Organizational Culture Theory

Since its emergence several decades ago, the concept of organizational culture has become one of the most influential, as well as controversial terms in organization research and practice. Despite the disagreements with regard to what organizational culture is, there seems to be, among scholars, no doubt that culture plays an important role in shaping organizations.

In the IS field, researchers have been studying the impacts of culture (at multiple levels, such as national, organizational and subunit) on IT issues for a long time. One stream of such studies focuses on the relationship between organizational culture and IT adoption [58–63]. For example, Hoffman and Klepper [60] found that organizations with mercenary cultures (*i.e.*, low in sociability and high in solidarity) perform better than organizations with more networked cultures (*i.e.*, high sociability and low solidarity) in technology assimilation. Information technology is not value neutral; instead, it is inherently symbolic and values lade [64–69]. Leidner and Kayworth [70] labeled the values attributed to IT by a group as IT culture. According to them, the degree of fit between organizational culture and IT culture plays an important role in IT adoption and diffusion. Therefore, in this paper, organizational culture would be proposed to have impacts on green IT adoption.

3.1.4. Resource-Based View

Resources-based view (RBV) was firstly proposed by Wernerfelt [71] to explain the competitive advantage of a firm in a strategic management field. It suggests that a firm's competitiveness is based

on its resources rather than products. Barney [72] extended RBV by proposing that, to have the potential of producing sustained competitive advantages, one resource must have four attributes: (1) valuable, in the sense that it exploits opportunities and/or neutralizes threats in a firm's environment; (2) rare among a firm's current and potential competitions; (3) imperfectly imitable; and (4) no strategically equivalent substitutes for this resource that are valuable, but neither rare nor imperfectly imitable ones exist.

Applying the RBV to the IT adoption context has the potential to make a theoretical contribution by identifying new and important drivers of competitive advantage. It provides a way for IS researchers to understand the role of the information systems within the firm [73]. By viewing IT as one kind of resource, RBV becomes a useful tool to explain the potential of IT as a source of sustainable competitive advantage.

3.1.5. Natural Resource-Based View

While the RBV proposes that firm resources with necessary attributes can generate sustainable competitive advantage, it systematically ignores the constraints imposed by the natural environment [30]. Recognizing the importance of environmentally-oriented resources and capabilities in generating sustainable sources of competitive advantage, Hart [30] proposed the natural resource-based view (NRBV) by incorporating the natural environment into RBV. According to [30], there are three strategic capabilities: pollution prevention, product stewardship and sustainable development, each with an emphasis on well-defined environmental objectives. The pollution prevention strategy aims to reduce emissions by adopting continuous improvement methods, whereas the product stewardship strategy seeks to minimize the environmental impacts of product systems by directing the selection of raw materials and disciplines product design. The sustainable development strategy, rooted in a strong sense of social-environmental purpose, aims at reducing environmental impacts of a firm's economic activities across the world.

Inherently, green IT adoption is consistent with the underlying assumption of NRBV. Through adopting green IT, organizations can acquire environmentally-oriented resources and capability, which, in turn, are the potential sources of competitive advantage.

3.2. Organizational Green IT Adoption: A Research Model

It is assumed that the green IT adoption studies involve a causal chain that begins with motivations and ends with green IT adoption. In this paper, we follow Simmonds and Bhattacherjee's [33] suggestion and view green IT adoption as the means to create sustainable competitive advantage. Synthesizing the theories discussed above and the literature examined, a research model is proposed to capture the predictors of the organizational adoption of green IT and the relationship between such adoption and organizational competitive advantage (Figure 1).

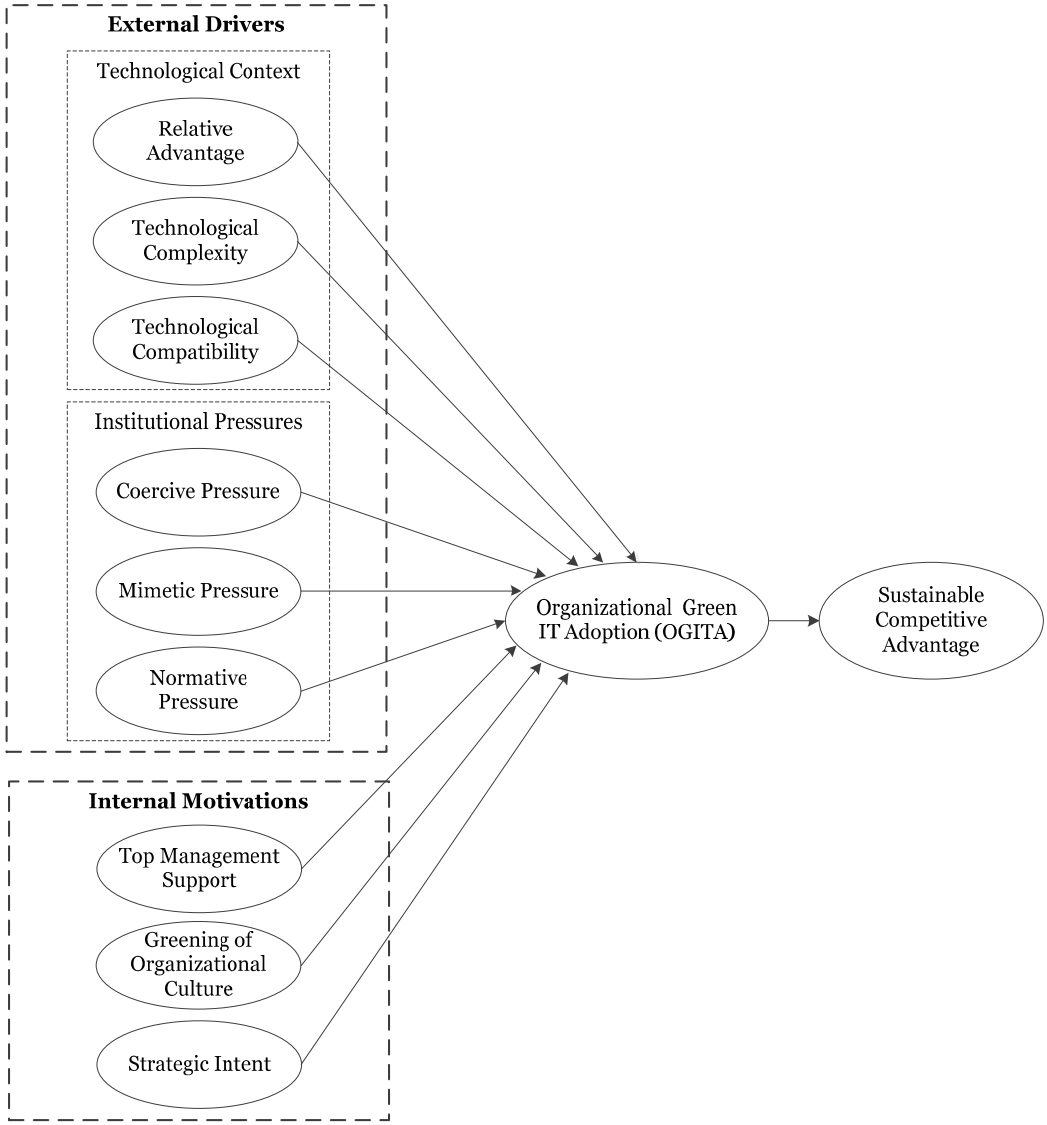

Figure 1. Organizational green IT adoption: a research model.

3.2.1. External Drivers

Externally, under the influences of technological development and economic, legal and social pressures, organizations may decide to adopt green IT so as to become more competitive. For the purpose of this paper, two distinctive factors are examined: technological context and institutional pressure. A number of propositions are formulated based on the theoretical reasoning.

Technological Context

From the technological context aspect, three innovation attributes are examined: relative advantage, technological complexity and technological compatibility. Several studies addressing IS adoption have included these attributes [42,46,47,74,75].

Relative advantage refers to the innovation being better than the technology it replaces, in terms of cost, functionality, "image", *etc.* Studies have found that relative advantage is positively related to IS innovation adoption (e.g., [76–78]). For organizations, several relative advantages come along with green IT adoption, such as cost reduction, emission reduction and transparency. In a highly competitive marketplace, these benefits are important considerations for organizations to adopt green IT.

Technological complexity refers to the difficulty of the innovation to be understood and used. Green IT includes technologies desiring human-technology interaction, such as virtualization, telecommuting, teleconferencing, *etc.* In this case, technological complexity can be viewed as the opposite of the ease of use or the perceived degree to which using a particular system needs much physical and mental effort [45,79].

Technological compatibility refers to an innovation's compatibility with the existing system (e.g., retained IT), including both hardware and software [45,80]. Technological compatibility has been identified as an important determinant of organizational IT adoption. The adoption of green IT can bring significant changes to extant technologies used in the organization. With such significance, resistance to change is a normal organizational reaction [81]. Therefore, it is important for the change to be compatible with the organization's extant technological infrastructure.

Based on the discussion above, the following propositions are proposed with regard to technological context:

Proposition 1a. Relative advantages will positively impact organizational green IT adoption.
Proposition 1b. Technological complexity will negatively impact organizational green IT adoption.
Proposition 1c. Technological compatibility will positively impact organizational green IT adoption.

Institutional Pressures

To avoid the potential confounding of normative pressure with mimetic and coercive pressures, some researchers address only mimetic and coercive pressures in the study of green IT adoption [9,23]. In this study, we examine three types of the institutional pressures to capture a holistic view.

Coercive pressure stems from political influence and the concern of legitimacy. Several studies have proposed that coercive pressure is an important predictor of green IT adoption [19,21,23,32,34]. In organizational adoption of green IT, the coercive pressure comes from environmental regulations/laws and important stakeholder's demands. On the one hand, regulations (national, regional and international) and environmental laws require organizations to operate in an environment-friendly way. On the other hand, the pro-environment demands from key stakeholders (such as consumers, vendors, suppliers) also force organization towards more of an eco-style.

Mimetic pressure results from standard responses to uncertainty. Undoubtedly, green IT adoption presents unknown challenges. At the same time, organizations also face the difficulties of measuring the environmental performances. Mimetic isomorphism suggests that organizations will follow leading organizations, which have realized benefits from being the first movers in the industry [32]. In case of green IT adoption, those indecisive organizations will likely be influenced by those having taken the initiatives to adopt green IT.

Normative pressure is associated with professionalization, and it shapes organizational responses. This is clearly seen when most large corporations are now addressing the triple bottom line and giving greater focus to improving their environmental performance [2]. Several previous studies have identified normative pressure as a predictor of green IT adoption [19,34,82]. As such, more and more normative signals are emerging, such as compliance with ISO 14001 Environmental Management Systems (EMS) and the Electronic Product Environmental Assessment Tool (EPEAT) and the formation of some environment-oriented associations, such as the Climate Savers Computing Initiative, Global eSustainability Initiative (GeSI) and The Climate Group [82]. When environmental operation becomes the norm, green IT, as one big environmental step, would be adopted by corporations facing great normative pressure.

Based on the discussion above, the following propositions are proposed with regard to institutional context:

Proposition 2a. Coercive pressure will positively impact organizational green IT adoption.
Proposition 2b. Mimetic pressure will positively impact organizational green IT adoption.
Proposition 2c. Normative pressure will positively impact organizational green IT adoption.

3.2.2. Internal Motivations

With regard to internal motivations, this paper includes three important internal "forces", namely top management support, greening of the organization culture and strategic intent.

Top Management Support

Top management support refers to support from the organization's top managers or champions (e.g., CEO or CIO) who recognize the values of an innovation and support its development and implementation [83]. Top management support has been labeled in many similar terminologies, such as champion support [9], management influence [34], attitude [32], managerial attitudes [37] and managerial interpretation [36]. Despite the disagreement on terminology use, it is commonly believed that top management support plays a crucial role in IT adoption.

Top management support is one of most effective predictors of IT adoption [47,84,85]. At the organizational level, it has been found to be a significant discriminating factor between adopters and non-adopters for new business processes and technological innovations [86,87]. In the case of green IT adoption, top management support can stimulate changes by communicating and reinforcing the values of the innovation in the organization [42], as well as creating a supportive climate for new technology adoption [81].

Hence, the following proposition is proposed:

Proposition 3. Top management support will positively impact organizational green IT adoption.

Greening of Organizational Culture

Recently, the concept of organizational culture has been applied frequently in the green management literature [88]. One stream of literature has focused on examining how the greening of the organizational culture can generate both economic and environmental benefits [89]. Adopting the resource-based view, some have proposed that the incorporation of environmental concerns into the organizational culture can deliver environmental capabilities that are hard for competitors to imitate [90]. Others, applying the strategic fit concept, have argued that failing to deliver the level of environmental performance demanded by green stakeholders could lead to undesirable performance [91]. It has been found consistently that organizational culture tends to shape the greening process by either supporting or constraining the institutionalization of green values [92,93]. Based on the theory of IT-culture conflict [70], the higher the vision conflict a group has with respect to a system, the lower the adoption rate of the system by the group. Inherently, green IT, which also pursues economic and environmental values, is highly consistent with green organization culture.

Hence, the following proposition is proposed:

Proposition 4. The greening of organizational culture will positively impact organizational green IT adoption.

Strategic Intent

The alignment between IT and organizational objectives is another important factor in organizational IT adoption [94,95]. The impact of such an alignment has been examined in several studies, e.g., [96,97]. Strategic intent has been studied in many areas, such as IT outsourcing [98], e-business adoption [99] and Enterprise Resource Planning (ERP) adoption [100]. Thus, the strategic intent of an organization to adopt green IT deserves further investigation. In this paper, we use strategic intent to examine the relationship between such alignment and green IT adoption.

Hence, the following proposition is proposed:

Proposition 5. The alignment between strategic intent and green IT adoption will positively impact organizational green IT adoption.

3.2.3. From Green IT Adoption to Sustainable Competitive Advantage

The application of the resource-based view in IS research started in the mid-1990s. Since then, numerous IS researchers have examined the relationship between IS resources and firm performance. In the IS field, IT has been viewed as both resources and capabilities, both of which have been proposed as potential sources of competitive advantage [101,102]. While NRBV extended RBV by incorporating the environment as a resource, strategic and competitive advantages are proposed to be rooted in the capabilities that facilitate environmentally-sustainable economic activities. Green IT adoption can be viewed both as the acquisition of IT resources and as improvement of IT capability.

Hence, the following proposition is proposed:

Proposition 6. Organizational green IT adoption will positively impact sustainable competitive advantage.

4. Conclusions and Discussion

Green IT has become an important and one of the popular research areas in the field of IS and in sustainability management. Among the research questions related to green IT, understanding why organizations adopt green IT is critical. Based on a review of predictors of green IT adoption proposed in previous studies and broad theoretical foundations, we proposed a research model for studying organizational green IT adoption (OGITA). The current study contributes to the existing literature in green IT and sustainability management research areas in two ways. First, differing from the general literature review, this paper systematically compared and summarized current studies on organizational green IT adoption. Through summarizing the previous studies of green IT adoption in organizations, this paper identified areas where significant works have been accomplished, which can be helpful for researchers interested in organizational green IT adoption in future studies. Second, drawing upon conceptualization in the diffusion of innovation theory (DoI), institution theory, organizational culture theory, resource-based view (RBV) and natural resource-based view (NRBV), we sought to propose a holistic research model to explain what motivates organizations to adopt green IT. Our model suggests that organizational green IT adoption is driven by both external drivers and internal motivations, which leads to sustainable competitive advantage. The model can provide researchers a roadmap for future study. In addition, this paper is beneficial to green IT practitioners, as well. For managers who are considering to adopt green IT in their organizations, the research model can be used as an analytical framework to support their decision making process. For those who have adopted green IT, the research model can help organizations by focusing on key performance indicators as identified by this paper. For policy makers, the model highlights their responsibilities and areas of influence in impacting the institutional pressures and, in turn, influencing organizational green IT adoption through the whole society.

However, this paper is not without limitations due to the limited scope and the early stage of the study. First, the internal motivation and external drivers have been treated separately, and the interrelationship between them has not been explored. Future studies can examine such a relationship, especially the impacts of external drivers on internal motivation. As far as we know, the external drivers have been confirmed to have impacts on internal motivation. For example, top management support can be negatively impacted by technological constraint and be positively impacted by coercive and mimetic pressure [32].

Second, although the current study focused only on the predictors at the organizational level, it does not imply that theories at the individual level, *i.e.*, the technology acceptance model (TAM), the theory of planned behavior (TPB) and the unified theory of acceptance and use of technology (UTAUT), cannot be applied to explain organizational green IT adoption. After all, whether to adopt green IT is a decision to be made by individuals. As previous studies identified, top management support is one of the important predictors of green IT adoption. In the decision making context, top management support could be viewed as a decision maker's acceptance of green IT. Furthermore,

"technological complexity" may be viewed as "ease of use", and "relative advantage" of green IT may be viewed as "usefulness" in the context of TAM.

Third, although the review in Section 2 has revealed a common gap of the impacts of technology-related predictors on organizational green IT adoption, the current study merely examined the question without examining any specific green information technologies. Green IT is a broad concept, which includes numerous technologies, such as e-commerce, virtualization, smart grids and cloud computing. From a practical perspective, the specific characteristics of different technologies should be considered as potential predictors of green IT adoption, so that the research results could be more informative and insightful. From the research perspective, including such characteristics can provide us with a broader theoretical foundation for studying green IT adoption. For example, in Bose and Luo's [9] study of green IT initiatives (e.g., virtualization), the process virtualization theory (PVT) was used as one of the theoretical foundations. Based on PVT and the characteristics of virtualization, they proposed four technological predictors (shown in Table 1). These four predictors may not be appropriate for other types of green IT adoption, even though they are important for predicting virtualization technology adoption. Future research should pay more attention to the effect of technological characteristics on green IT adoption.

Last, but not least, to create useful knowledge for organizations, the theoretical framework proposed in this paper should be further tested with empirical data. Due to the scope and time limitation, the research model proposed was not validated with cross sectional and in-depth case data. That said, we believe that the main concepts of the framework and ten propositions proposed with regard to the relationships between the constructs have laid the foundation for future study. Future studies can develop the model by setting the model in the context of adopting one specific green information technology and by examining the relationship between external drivers and internal motivation and test the model with empirical data.

Acknowledgments: We want to thank the anonymous reviewers of this paper for their valuable comments, and thank the external editor, who provided us with brilliant suggestions.

Author Contributions: Both authors contributed to the research design and model construction of this paper. Qi Deng contributed to the writing. Shaobo Ji contributed to the revision of the paper.

Conflicts of Interest: The authors declare no conflict of interest.

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