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Analyzing Frameworks for Green IT Adoption in Organizations: A Systematic Literature Review

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Abstract

Sustainability has emerged as a fundamental objective for organizations aiming to achieve the highest levels of maturity within various IT Governance Frameworks. Green IT has emerged as a concept aligned with the essence of organizational sustainability. Its primary challenge lies in the difficulty of integrating Green IT principles into the organization's business processes. Therefore, the framework employed plays a crucial role in facilitating the adoption of Green IT. This Systematic Literature Review uses Kitchenham to review various literature on the topic of Green IT adoption in organizations with a focus on their role in supporting sustainable behaviors. The review process shows the three primary frameworks, namely the Governance and Management Framework for Green IT (GMGIT), the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), and the Green IT Maturity Model. The analysis indicates that these frameworks are primarily employed in the IT services and manufacturing sectors, highlighting their effectiveness in addressing environmental sustainability, carbon emissions, and energy consumption. Gaps remain, especially in the government sector, where Green IT principles are underexplored. The research identifies challenges in executing these frameworks, specifically the tendency to favor short-term adoption strategies over long-term sustainability objectives. To enhance the success of Green IT adoption, firms at maturity levels 1-3 must initially evaluate their preparedness prior to fully integrating Green IT principles into their business processes. This study provides comprehensive insights into the frameworks utilized for Green IT adoption, including substantial recommendations for future research and practical applications in emerging domains.

Keywords: *Green IT Adoption, Sustainability, Frameworks, Systematic Literature Review.*

1. Introduction

Sustainability represents a fundamental goal for organizations that have attained the highest levels of maturity within various frameworks for information systems auditing. As explained by [1], at this level possess a sustainable development strategy is complemented by regular assessments. This approach is essential for optimizing operations and ensuring the organization's longevity. A pivotal aspect of sustainability is environmental responsibility, which involves mitigating the adverse effects associated with the utilization of information technology [2]. In this regard, environmental responsibility forms the core principle that gives rise to the Green IT concept, which emphasizes the adoption of environmentally conscious and sustainable IT practices [3].

The implementation of Green IT in organizations encounters several obstacles, such as resistance to change, insufficient awareness of long-term advantages, and constraints in resources necessary for execution [4]. Additionally, organizations frequently find it challenging to incorporate Green IT principles into their existing business operations, potentially resulting in inefficiencies and the misallocation of resources. Consequently, there is a pressing need for frameworks that offer actionable guidance for organizations to harmonize their business processes with Green IT principles. According to [5], these frameworks should be structured to aid companies in developing explicit strategies, setting measurable goals, and determining pertinent metrics to assess progress in the adoption of Green IT.

This study aims to identify various frameworks that can facilitate the adoption of Green IT within organizations and to evaluate the effectiveness of each framework in advancing corporate sustainability objectives. Through a systematic literature review, this research tries to deepen the understanding of the approaches that have been practically implemented, as well as to uncover the challenges and opportunities that organizations encounter in the pursuit of Green IT. The results are expected to provide valuable insights for practitioners and researchers in crafting more effective strategies to attain sustainability objectives through the integration of Green IT within organizations.

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Information Technology (IT) has become an integral component of business processes within organizations. Its rapid development compels many companies to continuously innovate to remain competitive in the marketplace. As elucidated by [6], Continuous Improvement and Continuous Development are central themes in the pursuit of organizational sustainability. The utilization of technologies such as Artificial Intelligence (AI), which necessitates greater processing power and energy consumption compared to other information technologies [7], can significantly contribute to climate change and the carbon footprint of organizations. Consequently, Green IT emerges as an innovative concept that integrates the optimization of information technology usage to minimize its environmental impact.

Research conducted by [8] underscores the critical role of Green IT in enhancing environmental sustainability within manufacturing enterprises. However, significant challenges exist in developing effective strategies for the adoption of Green IT in organizations. Based on findings from an Artificial Neural Network model, managerial interpretation and the establishment of responsibilities were identified as the two most influential factors in the process of adopting Green IT within companies. Similar correlations were observed in the findings of [9], which indicated that constructs such as self-efficacy, response-efficacy, and both extrinsic and intrinsic intentions within the Protection Motivation Theory (PMT) directly correlate with individual Green IT behaviors. Additional barriers to implementing Environmental Management Systems (EMS) in the construction sector include high costs, a lack of experience, expertise, and knowledge, particularly in adhering to ISO 14001 standards [10].

Small and medium-sized enterprises (SMEs) face the same challenges, struggling to limit the use of primary raw materials, achieve climate neutrality, and promote sustainable development while closing material loops [11]. A proposed solution to bridge the implementation gap is the Governance and Management Framework for Green IT (GMGIT), as articulated by [12]. This framework delineates the necessary characteristics for implementing Green IT within organizations. Before this framework, an approach was introduced to integrate the Green IT framework with organizational capabilities through Capability Maturity Model Integration (CMMI) [13]. The research findings indicated that Level 4 (Quantitatively Managed) and Level 5 (Optimizing) can assist companies and organizations in systematically and integratively implementing Green IT regularly. An alternative approach is presented by [14], who propose a five-level maturity model within the Green IT Maturity Framework. This framework outlines six key dimensions for guiding the implementation of Green IT in organizations, including organizational, technological, economic, environmental, social, and marketing aspects. Based on the findings, the proposed framework can be utilized to monitor and enhance the sustainability of operations within organizations. [15], provides an overview of the distribution of Green IT research, focusing on the phases of implementation. Based on the results found, in the post-adoption stage, the focus of research revolves around the external impact of Green IT solutions adopted by companies. Green IT is increasingly studied in a social context, no longer limited to the institutional environment, but there is still room for qualitative-quantitative research related to this phase. Based on the mapping of the last 20 years of papers conducted by Cordero et al. (2020), a new taxonomy of Green IT practices is proposed, categorizing them as behaviour-oriented and process-oriented.

2. Research Methods

In this study, we conducted a systematic literature review using the Kitchenham and Charters method. This approach was selected for its comprehensive process in identifying, evaluating, and interpreting research evidence, ensuring concise and precise answers to the defined research questions. The three main stages undertaken in this study are planning, implementation, and reporting .

2.1. Planning

The first step to be carried out was identifying the need for systematic literature review and its relevance to the topics. In this case, we evaluated existing studies and analyzed research gaps [16]. Furthermore, we developed a review protocol, comprising the background study, defined research questions, search strategies, inclusion and exclusion criteria, standards for selecting articles, criteria for evaluating the quality of research, data extraction strategy, synthesis methods and project timeline. Table 1 shows the research questions we had defined and agreed upon.

Table 1. Research Questions (RQ)

ID	Research Questions
RQ 1	What framework used for Green IT adoptions in the organizations?
RQ 2	What area does the organization sucessfully implemented the Frameworks?
RQ 3	What research gaps exist in the literature on Green IT framework?

2.2. Implementation

Once all researchers agreed on the predetermined protocol, the next step was to conduct the review. This includes executing a comprehensive search strategy to find relevant primary studies. In this case, we developed a search strategy with the keywords “Green IT AND IT Governance”, “Green IT AND Capability”, and “Green IT Framework”. We conducted initial searches across various databases, including IEEE, ScienceDirect, Elsevier, and Springer using the predetermined keywords. From these searches, 600 articles were identified and then sorted based on the inclusion and exclusion criteria. Next, we removed articles that did not meet the criteria, resulting in 18 articles selected for evaluation based on the quality assessment questions, as shown in Table 2. The 18 articles that passed the quality assessment were screened to extract the necessary data, which were then categorized by their framework, benefits, and research gaps.

Table 2. Quality Assesments (QA)

ID	Quality Assesments Checklist
QA 1	Is the Article were published in (2019 - 2024)?
QA 2	Is the Article were written on english?
QA 3	Is the Article were talking about Green IT, and other related topics?

2.3. Reporting

The reporting phase presents the answers to the research questions and visualizes them through diagrams and tables. In this phase, we also interpret the results by discussing the implications of the findings, comparing them with existing literature, and addressing any limitations encountered during the study. The final report summarizes the key findings, providing an overview of the research process and outcomes. The conclusions drawn from the analysis are presented with recommendations for future research or practical applications of the findings.

3. Results and Discussion

Based on the search process conducted, a total of 18 pieces of literature that meet the Quality Assessments (QA) criteria were identified. Table 3 outlines the author and ID of the papers found. While their distribution is illustrated in Figure 1. The majority of the literature included in this systematic literature review (SLR) falls under the Q2 category, comprising 5 entries. In contrast, the categories Q1 and Non-Q each account for an equal percentage of 22.2%, contributing 4 entries each. The Q3 category shows the lowest percentage at 11.1%, corresponding to 2 entries.

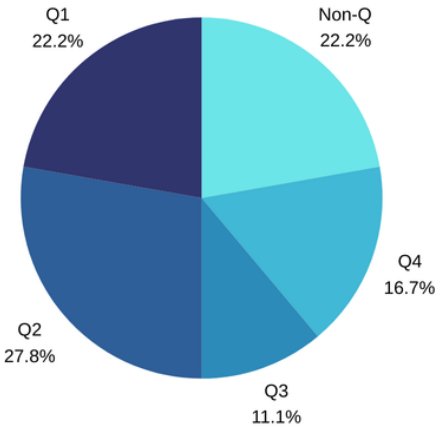

Figure 1. Literature Classification based on Quartile

The analysis of data based on publication year indicates that, out of a total of 18 pieces of literature, the year 2021 has the highest percentage at 31.6%, corresponding to 6 entries. This is followed by the years 2022 and 2019, each accounting for 21.1% with 4 entries. The year 2023 contributes 15.8%, representing 3 entries, while the years 2020 and 2024 each exhibit the lowest percentage at 5.3%, with 1 entry each. This suggests that the majority of the analyzed research originates from 2021, while the other years display a more varied distribution. This distribution is illustrated in Figure 2.

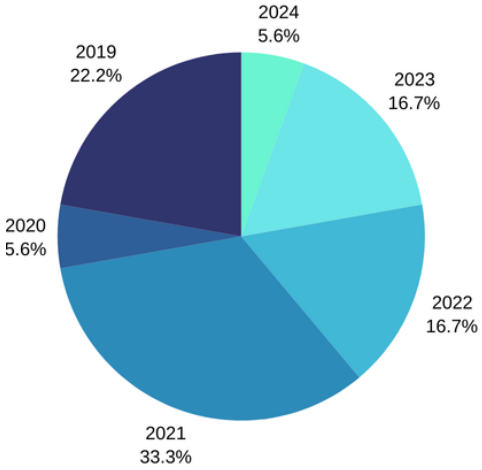

Figure 2. Literature Classification based on Years

RQ1. What frameworks are used for Green IT adoptions in the organizations?

Among the 18 papers analyzed, the most commonly used frameworks are those that assess organizations' readiness to adopt Green IT. In this regard, the identified frameworks include CMMI, the Green IT Maturity Model, and ISO/IEC TR 33014, which were employed in five papers. These frameworks aim to enhance sustainability and improve the efficiency of organizational operations in Green IT adoption.

Another set of widely used frameworks explores the factors influencing Green IT adoption among organizations and users. It includes the Technological-Organizational-Environmental (T-O-E) framework, the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), the Technology Acceptance Model (TAM), Innovation Resistance Theory, and the Decomposed Theory of Planned Behavior (DTPB), Artificial Neural Network (ANN), and Structural Equation Modeling (SEM). Their application helps practitioners promote Green IT by emphasizing user-friendly design and addressing passive resistance.

Several studies have also discussed integrating the IT Governance Framework with Green IT. Firstly, GMGIT is a framework that provides comprehensive guidelines to implement and improve the governance and management of Green IT, which inherits the structure of COBIT 5. Its second version integrated COBIT 5 with the ISO/IEC 33000 maturity-based model, which the researchers updated to the ISO/IEC 33014 maturity-based model to be more specialized in the process and operations of the organization. Apart from GMGIT, another notable Green IT Governance model is the Green Balanced Scorecard Framework, proposed by [17]. This framework supports organizations in monitoring and managing Green IT initiatives and contributes to sustainability in Green IT operations.

Lastly, two papers designed models that provide recommendations for Green IT adoption and actions to the decision-makers. The FACIIL framework by [18], forecasts the environmental impact of strategic and operational decisions in the Barreiro municipality. Moreover, the Intelligent Framework of IT Ecological Governance by [19], combines artificial intelligence with a Green IT governance framework, providing ecological recommendations based on Green IT standards in the form of action plans. The two papers contribute to the guidelines of Green IT principles in decision-making and governance.

Table 3. Framework Used to Adopt Green IT

No	Framework	Related Literatures
1	Organizational Green Computing Embracement Framework	[20]
2	Consolidated Framework for Implementing Green Practices	[20]
3	Green Balanced Scorecard	[17]
4	CMMI-based Maturity Model	[13]
5	GMGIT	[12], [21],
6	Technological-Organizational-Environmental (T-O-E) Framework	[22]
7	Artificial Neural Network (ANN) & Structural Equation Modeling (SEM)	[8]
8	Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)	[23], [22]
9	Green IT Maturity Model	[24], [14]
10	ISO/IEC TR 33014	[25]
11	Technology Acceptance Model (TAM)	[2], [23]
12	Innovation Resistance Theory	[2]

13	Resource-Based View	[26]
14	Natural Resource-Based View	[26]
15	COBIT 5	[27]
16	FACIIL	[18]
17	Intelligent Framework of IT Ecological Governance	[18]
18	Decomposed Theory of Planned Behavior (DTPB)	[23]

RQ 2. In what area does the company/organization successfully implemented the Frameworks?

Green IT adoption has been widely studied in the IT services and manufacturing industry due its significant impact on energy consumption, carbon emissions, and environmental sustainability. Their findings show that the adoption of green IT in the services and manufacturing sectors contributes to the sustainable implementation of green initiatives. However, research on Green IT in other sectors like government, public administration, farming, and banking remains underexplored, indicating the need for broader study to strengthen empirical evidence.

In the public sector, a study on Saudi Arabia's government explored Green IT adoption in response to the increasing environmental impact of IT products in Gulf Cooperation Council (GCC) countries. The findings emphasize the importance of user-friendly design and overcoming passive resistance to adoption. Similarly, a study in Portugal's public administration developed an ICT management framework with predictive indicators for assessing environmental impacts. The study demonstrated that advanced technology choices reduce energy consumption, costs, CO_2 emissions, and deforestation.

Beyond government, Green IT has been applied in sustainable farming in India, aiming to minimize energy consumption and ecological impact throughout the lifecycle of computing devices. The banking sector has also embraced Green IT, driven by motivational, technological, organizational, and environmental factors to enhance efficiency and reduce environmental harm. These diverse applications underscore the growing significance of Green IT across industries, though further research is necessary to explore its adoption in underrepresented fields.

Table 4. Sector of Framework Implementation by Organizations

No	Field Category	Related Literatures
1	IT Services	[27], [18], [13], [26], [28], [5], [21], [12], [25]
2	Manufacturing	[26], [8]
3	Government	[2]
4	Public Administration	[18]
5	Farming	[20]
6	Banking	[22]

RQ3. What research gaps exist in the literature on the Green IT framework?

The literature on Green IT frameworks reveals several significant gaps. Firstly, there is a lack of studies on standards, frameworks, and auditing practices for Green IT, highlighting that this area is still underexplored. Existing studies also indicate that many organizations lack adequate experience in Green IT governance and auditing. [29] addressed these gaps by proposing a framework called the 'Governance and Management Framework for Green IT (GMGIT). Additionally, [13] stated that there are only a few studies on the completed and validated Green IT maturity models; consequently, they designed the maturity model to be integrated with GMGIT. However, less attention has been paid to the evaluation of Green IT strategy performance through IT governance frameworks. Hence, a Green Balanced Scorecard Framework by [17] focuses on developing a strategic map for monitoring the Key Performance Indicators (KPIs) essential for Green IT governance.

While the Normative Activation Model (NAM) has been widely applied in studies on environmentally friendly behaviors, NAM has not been extensively studied in the context of Green IT implementation to explain how individuals take responsibility for environmental decisions and behaviors. There are recurring concerns about its efficiency in predicting environmentally friendly decision-making. Thus, the study by [8] addresses this gap by integrating subjective norms and managerial interpretations into NAM to enhance its predictive power for Green IT adoption.

The comparison model of TAM, UTAUT, and DTPB has been widely applied in other areas (e.g., e-banking, online banking, business IT), but its application to Green IT remains unexplored. There is also no clear consensus on which model is most effective for predicting Green IT adoption. [13] proposed a comparative analysis of competing models to determine the most effective approach. On the other hand, [2] stated that prior studies have explored Green IT adoption at the organizational level, neglecting the perspectives of individual system users' beliefs and behaviors regarding Green IT. Although some research has primarily used TAM to

analyze adoption, they often overlooked long-term usage behaviors and resistance factors. This study addresses this gap by investigating both dimensions, offering a deeper understanding of factors that impede Green IT adoption.

Existing studies primarily measure short-term impacts using parameters such as carbon emissions, green certifications, and life-cycle assessments, without assessing how these initiatives perform over the long run. Although the continuity of programs has been examined in other sectors (e.g., social and healthcare), this aspect has not been applied or tested within the context of Green IT. Therefore, the research of [13] aims to fill this gap by developing a framework for the long-term impact measurement of Green IT, incorporating factors that influence the sustainability and continuity of these initiatives.

3. Conclusion

Green IT Adoption serves as a means for organizations to support sustainability goals. Frameworks act as catalysts that facilitate the implementation process for these organizations. Based on the findings from a systematic literature review of 18 relevant studies, four frameworks that are most frequently discussed include GMGIT, UTAUT2, the Green IT Maturity Model, and TAM. The sectors where these frameworks are implemented primarily revolve around companies engaged in IT services and manufacturing. Within the IT services sector, there are numerous areas for future research, such as Cloud Computing, AI, and Blockchain. Additionally, the government sector presents significant opportunities for implementation. A key challenge identified in the implementation of these frameworks is that many focus solely on short-term Green IT adoption, emphasizing factors such as energy consumption, carbon emissions, and environmental sustainability. For long-term Green IT adoption, it is essential to assess the organization's maturity level prior to implementation. Companies at maturity levels 1-3 are not yet able to fully integrate Green IT principles into their business processes. It is hoped that this research provides a comprehensive overview of the frameworks utilized in the adoption of Green IT.

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