Individual and Organizational factors affecting the implementation of Green IT: A case study of an Indian business school.

Abstract

Green Information Technology (Green IT) emerged as a critical research agenda for reducing organizations' carbon footprints to achieve environmental sustainability. This paper aims to understand the factors that affect the adoption of Green Information Technology in the context of a developing country. Studies that have focused on both individual and organizational level factors (multi-level approach) remain limited. The Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), and Technology-Organization-Environment (TOE) framework was used as a theoretical lens to address the gap in the literature. The theoretical background and participatory case study (qualitative) as the methodology was used to investigate the factors at multiple levels that could affect Green IT implementation in the developing country context (Indian business school). The findings reveal that three key dimensions affect the implementation of Green IT- Need, Scope, and the Inclination to adopt Green IT. Each dimension includes a mix of factors at the individual and organizational levels. This paper contributes to theory by proposing a framework for multi-level Green IT adoption. It also provides guidelines to the practitioners for considering the intervention factors at the individual and organizational levels.

Keywords: Green IT, Implementation, Motivation Factors, Green IT Drivers, Actual Green IT Behavior.

1. INTRODUCTION

Information and Communication Technologies (ICT) are increasingly contributing to the global carbon footprint. Green ICT deals with two aspects of sustainability; one deals with the environmental impact of ICT (two percent of the global carbon emissions). The other uses ICT to solve the issues related to sustainability (Nanath and Pillai, 2014). It is usually considered as a synonym to environmentally sound Information Technology (Murugesan, 2008). The ICT industry's overall emissions can be attributed to three sectors- Telecommunications, Data centers and Personal Computers (and other IT devices), and Green IT, play a significant role in reducing

the emissions from all three sectors. Current estimates attribute IT emissions at 8% of electric power in 2016, growing to 13% by 2027 (Kim *et al.*, 2017). Considering the number of computers worldwide, that may exceed 2 billion compared to 600 million vehicles (Weiss, 2007).

The adoption survey of Green ICT revealed that the market is proliferating, with more firms implementing Green ICT over the years (Mines and Davis, 2007). However, several issues have been reported in the Green IT implementation, resulting in lower adoption rates in developing countries (Jonathon, 2012). This paper explores the Indian Green ICT context. It has been observed that the adoption in the Indian context and several other developing countries is still in the initial stages (Khor *et al.*, 2015; Ozturk *et al.*, 2011). India has the fastest-growing telecom sector globally, and energy/power consumption is the most prominent contributor to carbon emissions in the industry (TRAI, 2017). With the energy costs going high, it is becoming vital for the players in the Indian ICT sector to scale up the implementation of Green IT.

According to the Telecom Regulatory Authority of India (TRAI), the carbon emission level from the Indian ICT sector jumped by more than 70% from 2015 to 2017. It also states that the top share of carbon emissions in the ICT infrastructure is during the actual use of network devices. With the scalping up of 4G, the introduction of 5G, rapid penetration of smartphones, and affordable internet prices in India, the rapid use of devices and disposal (e-waste) will lead to significant sustainability concerns in the nation. Therefore, Green IT implementation is imperative for the organizations, but it is also essential for the deployment scale to rise with the demand. The 2030 Indian green growth and sustainable development agenda also emphasize using technologies to reduce carbon emissions (GGGI, 2015). Therefore, research on factors that facilitate and inhibit the adoption of Green IT is vital in the context of developing countries like India.

Several studies have highlighted the lack of research on engagement with Green IT initiatives (Elliot and Webster, 2017; Molla and Abareshi, 2011). It has been noted that most of the studies have used one base theory (Elliot and Webster, 2017) like the Technology Acceptance Model (TAM), Belief-Action-Outcome (BAO) framework (Melville, 2010; Ojo *et al.*, 2018), or the theory of reasoned action (TRA, Mishra *et al.*, 2014). These theories are almost techno-centric and thus address individual-level adoption. However, the decision to adopt Green IT is also influenced by organizational factors like financial issues, resource availability, infrastructure, and others

(Chen *et al*., 2010). Therefore, several studies have discussed the importance of organizational-level factors in the context of Green IT adoption.

However, the use of single theories could result in a limited perspective to explore Green IT adoption. The limitation could be that unidimensional studies might fail to offer a holistic approach to Green IT implementation. Moreover, organizations are idiosyncratic to individuals and decision-makers' extent, reflecting their cognitive assumptions (Hambrick and Mason, 1984). The uniqueness of individual actors shapes a firm's strategic focus. Therefore, the interconnected nature of individual and organizational-level factors calls for a model that could include both the level of analysis (Samad *et al*., 2020) to accommodate a range of factors affecting Green IT implementation.

This paper attempts to study the factors that influence the intention to adopt Green IT practices using a multi-level approach. The proposed model in this research uses the Technology-Organization-Environment framework, Theory of Reasoned Action, and Theory of Planned Behavior as a theoretical lens to study Green IT adoption. The use of theories at multiple levels is based on the prescription for the dominant paradigm (using predictor and linage analyses) in IT adoption by Jeyaraj *et al*. (2006). They recommend including individual characteristics in organizational adoption studies as an organization's decision to adopt and implement a technology is made by individuals within that organization. They also suggest the use of macro variables and environmental characteristics in individual adoption research. It is essential to understand the variables like the pressure of adoption differently for organizations and individuals. Therefore, theories that could offer both perspectives are used in this study.

The methodology used in this study was a qualitative approach with a participatory case study method. The organization chosen for the case study approach was a Computing Center of leading Business schools in India. The case study describes different phases of green IT implementation in the form of Grid Computing and documents the structured interviews over three months and three phases. The first phase reviews the existing practices and protocols at the Computer Center and understands the computing practices of the staff and students at the university. The case then proceeds with deploying a pilot study to understand the idle times and under-utilization of computers at the Computer Center. It was followed by the implementation of grid computing and the analysis of resource utilization.

The article proceeds as follows. Section 2 reviews the relevant literature and addresses the research gap for multi-level research. Section 3 discusses the theoretical lens used in this study, while Section 4 outlines the research methodology used in this study. The next section (Section 5) presents the Green IT case study description, followed by the discussion in Section 6. The concluding section (Section 7) provides the proposed framework for this research.

2. RELATED WORK AND REVIEW

Green IT has been perceived as a vital component of environmental sustainability that consists of corrective measures to meet the current needs and support upcoming generations (Chou and Chou, 2012). It has multiple dimensions of environmental sustainability: 1) protecting the environment by GHG emissions, 2) social imperatives and total cost of ownership (Chou and Chou, 2012), and 3) energy efficiency (Singh and Sahu, 2020).

The implementation of Green IT has been studied well in the literature. Several researchers have studied the factors that could lead to the successful implementation of Green IT (Molla, 2008; Bose and Luo, 2011; Shevchuk and Oinas-Kukkonen, 2019). A few review papers have categorized these factors into organizational, motivational, and regulatory compliance (Singh and Sahu, 2020). Nineteen success factors were explored by Sahu and Singh (2016), and it included organizational structure, industry vision, strategy, resource allocation, training, and other organizational factors. These factors have always been an exciting topic of research in the literature as different factors emerge from various Green IT contexts. However, limited information is available on how factors at various levels (multilevel research) operate within a shared context.

One of the problems highlighted by Jeyaraj *et al*. (2006) in the technology implementation research is the lack of integration and understanding of the linkages between individual and organizational adoption of IT. Most of the studies have been exploring a common research question: What factors facilitate or hinder IT innovation's implementation within potential adopters? (Fichman, 2004). However, this question is not being explored under the common umbrella of two units of analysis: Individual and Organizational. This paper adopts the definition of these units proposed by Jeyaraj *et al*. (2006). An individual unit of analysis refers to the research that examines the implementation and diffusion of Green IT and related innovations by individuals (like motivational factors, compatibility, individual behavior, outlook, and others). The

organizational level of analysis refers to the research that examines the implementation and diffusion of Green IT and related innovations by organizations or organizational units (like organizational size, top management support, funding, slack, competition, and others). A summary of Individual and Organizational factors affecting Green IT implementation is summarized in Table-1 and Table-2, respectively. As can be observed, the literature stands divided into two units of analysis- Individual and Organizational. While a few studies describe both levels in a joint study, a lack of conceptual model incorporating both levels is evident.

<<Insert Table-1 here>>

<<Insert Table-2 here>>

3. THEORETICAL FOUNDATION

Since Green IT adoption is a technology-based phenomenon, widely accepted technology adoption frameworks were reviewed to frame this research's theoretical foundation. Scholarly inquiries propose frameworks that explain technology adoption, and they underpin several studies in the Information Systems domain. While some frameworks use individual-level factors, others use organizational-level factors that significantly affect the implementation of technology. However, it could be essential to consider both the levels in the same study, as the implementation and adoption of any technology is defined by organizational and individual-level decisions to accept and use it in the long run to solve problems (Musawa and Wahab, 2012).

The multi-level approach is inspired by several studies that highlight the importance of individual context in enriching the frameworks that consider only organizational-level factors like technological, organizational, and environmental contexts (Premkumar, 2003). They emphasize that enterprise-level innovations largely depend on decision-makers' functional and emotional feelings (Awa *et al.*, 2015). This could reflect their attitudes, perceptions, motivation, and other individual-level factors. Further, several studies have also recommended that analyzing the organization's dynamics and technology adoption issues could be incomplete without explicit knowledge of the manager's future assumptions, alternatives, and attitude (Awa *et al.*, 2015; Venkatesh *et al.*, 2003). Therefore, given the interdependency of organization and individual-level factors giving way to the ensemble view of technology, it was decided to consider theories at both

levels. Technologies like Green IT and user behavior coevolve as a structuration process during human-computer interaction (Masino and Zamarian, 2003).

While multi-level theories have been suggested for technology adoption in general, it is essential to understand the importance of using them in the context of Green IT. There are several reasons why Green IT is different compared to other technologies where adoption and implementation frameworks have been applied in the past. Green IT initiatives also differ from other sustainability initiatives, and hence a new theoretical model for adoption could be an exciting proposition. Green IT initiatives typically take a more extended period to break even and are likely to be motivated by softer aspects like employee motivation than financial gains (Olson, 2008). Further, regulations and legislative actions play a crucial role in adopting Green technologies, and firms might be forced to adopt green technology without actual intentions (Olson, 2008). Organizations try to balance the environmental impact and economic value (business value and cost-saving) in green technologies, which might affect the pace of adoption (Esty and Winston, 2006). Therefore, this study attempts to develop a model to study the factors that affect the intention to participate in Green IT initiatives and actual Green IT implementation.

In various studies, researchers recommended that studies dealing with multi-level models dealing with organizational issues need to be explicit regarding the theoretical level of origin and the corresponding measurement level for their constructs (Seibert *et al*., 2004). At an individual level, the theories typically deal with an individual's behavioral intention to adopt an innovation or actual implementation behavior. The theories generally propose that the beliefs affect attitudes, which in turn impact the intention and behavior. On the other hand, organizational level theories have examined IT adoption at various levels like functional units (Ravichandran, 2000) and the entire organization. Several IT innovations and technologies have been examined using these theories, and they include electronic data interchange, smart-card payment systems, and other technologies. Their application in Green IT could help assess the set of theories that could serve as a theoretical lens for this research.

To develop the theoretical lens of this research, several theories were reviewed: Theory of Reasoned Action/Theory of Planned Behavior, Technology Acceptance Model (TAM), Technology, Organization and Environment model, TAM 2, Unified Theory of Acceptance and Use of Technology (UTAUT) and Diffusion/Implementation Model. Each theory was examined

for adopting it to establish a framework for Green IT implementation in developing countries, using the Indian context as a case study. The examination of these theories was conducted based on three parameters: 1) Unit of Analysis being Individual (Ind.) or Organizational (Org.); 2) usage in the context of Green IT implementation and 3) prior studies in the context of sustainability developing countries. The evaluation of technology adoption theories for Green IT adoption in developing countries is presented in Table-3.

<<Insert Table-3 here>>

Therefore, based on the evaluation of theories presented in Table-3, the authors used the TOE framework, TRA, and TPB to capture the two levels (individual and organizational) of analysis adequately. TRA and TPB could be applied in the context of Green IT because literature has already shown the relevance of this theory in Green Computing practices (Chow and Chen, 2009). Further, it is a well-known fact that consumer beliefs influence purchasing power. Atran *et al.* (2005) revealed that environmental beliefs are no different, and thus the adoption of Green IT would depend on the belief and behavior of the decision-maker. Theory of Reasoned Action states that an individual's conscious belief and behavior depends upon his/her intention to perform a given action. The intention is, in turn, influenced by attitude (favorable/ non-favorable) and subjective norms (Ajzen,1991). The theory of Planned Behavior expands TRA by adding perceived behavioral control, which talks about the perceived power of the control beliefs that may facilitate or impede the behavior's performance.

The actual Green IT behavior is taken up differently from the intention to participate in Green IT because of the differences shown in the literature. Studies in Green IT research have shown that even if managers have positive intentions to adopt Green IT, they still might not implement it (Esty and Winston, 2006; Olson, 2008). On the contrary, firms might implement Green IT due to regulatory compliance despite having no intentions to participate in Green IT initiatives. This demonstrates a gap between awareness and action in Green IT and opens up new research dimensions to explore the differences.

TOE framework was chosen as a theoretical lens to study the implementation of Green IT at an organizational level. Green IT is perceived in the literature as an IT-dependent strategic initiative that could provide a firm with a competitive advantage. Further, these initiatives are also

part of the technological innovation that aims to reduce the environmental impact of IT in an organization. The literature has shown confidence in using this theory to explore the adoption and assimilation of IT innovations and technological inventions (Miscione and Johnston, 2010; Oliveira and Martins, 2010). According to this framework, adoption and implementation of technological innovations are influenced by three elements. The technological context being the first, which refers to properties of technology that are available for possible adoption and the current state of technology in an organization. The second element is the organizational context, which consists of organizational structure, culture, size, leadership, and other properties idiosyncratic to the concerned organization implementing Green IT. Lastly, the environmental context combines elements of the industry, regulation, and government incentives.

4. RESEARCH METHODOLOGY

This paper's methodology was a qualitative, participatory case study (Reilly, 2010). It is a mode of case study research that involves the participants and local groups in all phases of the research process and has been used in the context of sustainability (Kirono *et al.*, 2014). The process is collaborative and emphasizes all relevant parties' participation and contribution in examining an issue (lack of Green IT practices in this case). Its outcome is to change and improve the situation and an understanding of factors that affect the change (Reilly, 2010). In general, qualitative research involves analyzing non-numerical data to understand the concepts that could involve human and social interpretations (Creswell, 2003). Within qualitative research, Information Systems researchers have emphasized user participation in the design of effective IS (Byrne and Sahay, 2007).

There are two reasons why the participatory approach was chosen for this research. On one level, the authors could be involved in developing and designing the systems that will shape the overall Green IT implementation in the business school. On another level, some of the implementation's technical issues could be resolved by a participatory-based approach. Since the research seeks to understand the interactions between technology, social contexts, and individual behaviors, the participatory approach could strengthen multi-level research. Therefore, the participatory case study is selected to develop a Green IT implementation framework in developing countries.

4.1 Data Gathering

In line with the participatory case study approach and interpretive case study guidelines (Reilly, 2010), data was gathered from multiple sources. The sources included interviews, documents, observations, the business school website, and other secondary data sources. Data was collected over the entire duration of the participatory case study (three months). The authors collaborated will all the stakeholders in the case study to plan the design (participatory case approach). Several semi-structured interviews were conducted with informants who were either influential in making Green IT decisions or could implement the technologies on the ground. The participants were selected through purposive sampling (Creswell, 2003) from various departments of the business school shown in Table-4.

This participatory case study was executed in three stages. Phase I of the study involved benchmarking of the IT infrastructure to figure out the environmental impact of IT in the business school. This was followed by Phase II, where a pilot study was conducted to demonstrate the institute's current utilization of system resources. The last stage (Phase-III) was the implementation of Grid Computing to utilize the system resources effectively. The interviews were conducted before and after each phase of the case study. However, the frequency and length of interviews increased as the approach moved from Phase I to Phase III. The authors adopted flexibly designed interview guides that accommodated insights from Green IT implementation. The involvement of participants in various stages is also provided in Table-4.

<<Insert Table-4 here>>

4.2 Data Analysis

Data analysis aims to understand various factors that affect the adoption of Green IT in developing countries. The data analysis occurred alongside data gathering and was shared with the participants regularly following the participatory case study (Reilly, 2010). The theoretical lens used for the analysis was the Theory of Reasoned Action and Planned Behavior with the TOE framework. However, the goal was not to test the theory but use it as a sensitizing device to comprehend the factors that emerge from the data.

All the interviews were transcribed, categorized, and coded. Each author conducted an independent, participatory analysis but frequently met to discuss the emerging categories. Follow-up meetings were organized to gather additional data if required, keeping the participatory case study's collaborative approach. Peer review was done by a colleague (External/Academic Researcher) to check the reliability and validity of the interview and interpretation. The analysis ended when the participatory case study led to a collaborative solution (Phase III) and when theoretical saturation was reached, resulting in no new insights (Day *et al*., 2009).

The role of authors in the case study implementation was beyond conducting interviews and analysis. They were part of the green IT implementation process, and thus the case demonstrated an effective participatory approach. First, they initiated the Phase-I of the case and developed a benchmarking report of Green IT practices that were shared with the institute's key stakeholders. This helped individuals in understanding the gaps and setting up targets for Green IT implementation. In Phase-II, the authors developed the application that could measure the idle system time of the resources. This demonstrated the system underutilization and hence created a need for the organization to implement technologies that could increase the computing efficiency. In Phase-III, they recommended the suitable Green IT platform (Grid Computing) and collaborated with the IT administrators for effective implementation. Therefore, authors were involved in all phases of the case study and provided critical inputs in Green IT implementation.

5 CASE STUDY: GREEN IT IMPLEMENTATION

The participatory case study was implemented in the computer center of a leading B-School in India. The implementation started with reviewing existing green computing practices at the computer center and suggested the organization with a Green IT implementation strategy. After presenting the strategy, a pilot study was conducted to understand the idle times and under-utilization of computers at the computing center. It was followed by implementing grid computing (one of the Green IT technologies) and analysis of system resources utilization. The initiative was not limited to the computers of the computing center alone, but it involved computing resources of the entire organization (including students and faculties' personal computing devices). To kick start the organization-wide initiative, it was required to incorporate sustainability practices and awareness in the institute's research, teaching, consultancy, and social development projects.

The description of the case study is divided into three sections. The first section provides the details of the organizational setup for the business school. The second section describes the different phases of Green IT implementation in the computer center of the institute. The results of the implementation are provided in the third section.

5.1 Organizational setup for Green IT implementation

The organization under study is a leading business school in India. It uses powerful computers to support diverse computing requirements, access to bibliographic databases and archives for rapid retrieval of relevant information, and updating/disseminating academic and research material. The computer center of this business school hosts more than five hundred PCs available for use round the clock.

The IT setup at the business school comprises of a multi-layered architecture, the lowest layer of which is made up of personal computers and workstations. The next layer consists of File servers and Database servers. The third layer consists of the Web server, FTP server, Email server, and other high-end servers. The entire campus has been Wi-Fi enabled to provide mobility to the users in accessing various services available on the institute's network. All the buildings on the campus are interconnected through a six-core SMF Gigabit Fiber Optic backbone. The computer center acts as the central hub of the network and hosts a layer 3 backbone switch.

Interviews with IT managers at the computing center revealed the current status of Green IT. It was reported that the organization had no special initiatives or proactive measures towards environmentally sound computing. As part of the participatory approach, the authors prepared a report to document the existing practices and share them with the relevant stakeholders. However, the computer center was adhering to environmental standards, and the procurement of the lab equipment followed basic environmental standards. Apart from the regulatory compliance initiatives, the organization ensured low commuting cost of staff/faculties using high tech rooms equipped with state of the art ISDN and IP based videoconferencing facilities. Therefore, there were no Green IT initiatives of considerable scale in this organization.

5.2 The initiative of Grid computing implementation

The first phase involved the benchmarking process in understanding the status quo. Benchmarking is defined as estimating system performance by using multiple workloads and measuring the performance (Jones, 1975). It is used to determine the best equipment to buy in various technology insertion cycles when the standards/recommendations regarding computer hardware procurement are concerned (Letmanyi, 1984). This step remains pivotal in setting up environmental objectives/targets for an organization to reduce computing's environmental impact.

Benchmarking can be used by the computer center to measure its carbon footprints and set its carbon emission reduction goals. Direct and indirect emissions should be included in the design of metrics and models required to incorporate benchmarking and transparency. This has been one of the top priorities of organizations looking to implement Green IT in their organizations. There are various calculators available to give a rough estimate of carbon emissions. The authors selected a basic version of Microsoft's Green IT calculator (Microsoft, 2010). This calculator is used only for the estimation of the environmental impact involving desktops. However, there are different calculators available for benchmarking the servers. The inputs for calculation (Table-5) were no. of PCs, LCD usage, and operating systems. There were more than 500 PCs, with 76% using LCD. The output of the Microsoft Energy calculator revealed that the computer center incurred very high power costs and was responsible for 367.1 tons of carbon emissions. If the same activity were performed for the entire organization, including servers, the results would be more massive. The output shown in Table-6 clearly shows the potential impact on the environment made by the organization's IT infrastructure.

<<Insert Table-5 here>>

<<Insert Table-6 here>>

Based on benchmarking results, a detailed Green IT strategy was presented by the authors to the institute. This document included various Green IT initiatives that the organization could undertake and become a greener organization. These initiatives included efficient data centers, cloud computing, use of thin clients, management of e-waste, printing, and green procurement of the IT equipment. Each initiative had a description and plan that was outlined in the document.

Phase II of the implementation involved a pilot study in finding the utilization of system resources in the institute. This step was needed because the institute expressed its interest in implementing Grid Computing that could reduce the underutilization of the systems. However, they demanded the understanding of economic benefits associated with Grid Computing and wanted to know if their computers were underutilized. Top management demanded reports on existing utilization to decide upon the implementation of Grid Computing. It was then decided to study the computing usage patterns of staff, faculties, and students in the business school. An active experimental setup could capture the usage pattern and report the utilization of the computers at the institute. The authors developed the application for this experiment in various steps.

The first step of the experimental setup was to establish rules that could define the system's non-utilization. It was decided to figure out the no. of times a computer entered into the state of being idle and the time for which it remained in that state. Idle time is defined in this paper as inactivity of the computer for more than 30 seconds. Thirty seconds might appear a short time to declare a computer in an idle stage because a user could be watching a video that could lead to an inactive stage. However, the rule established here is an appropriate measure because the systems monitored were in the B-School computing center, where the usage of videos is not encouraged. Therefore, no activity (lack of instructions) for more than thirty seconds would classify a computer as being in an idle state.

The authors developed an application, and it was installed in all the systems being monitored with the help of the IT staff in the business school. This application records the start/end time of monitoring and the number of times a system goes idle. It also notes down the extent of time to which the system remained idle in each case. Hibernation mode and 'log-off' modes were not considered because they already have power savings mechanisms. Hence, these states cannot be attributed to underutilized computing resources (Lock state was taken into account). The details recorded in the database for a sample of students in the business school are shown in Table-7.

The usage patterns for all the users were aggregated to gain insights into two parameters. The first being the average number of times a system goes idle in an hour. Secondly, the average time for which the system remains idle each time it goes into the idle state. The summary of results is shown in Table-8.

Results reveal that the systems under study were idle for more than fifty percent of the running time. This excludes the time during which the system had been logged-off. If it were to be included, the system utilization would be far lower than fifty percent. This experiment revealed an acute need for using green technology to utilize these idle times. These results were presented to the IT administration department of the institute. They had a close look at the experimental setup and results, following which they expressed their interest in implementing Grid computing. Therefore, it was decided to host an application on the grid in the institute's computer center.

The last phase- *Phase III* of the implementation was the actual setup of the grid computing platform at the computer center of the institute. This part of the study involved the execution of an application that required intense computing resources. This application used the open-source .NET-based framework of Alchemi (Akshay *et al*., 2005) and its libraries for development. Alchemi provides the runtime machinery and programming environment required to construct grids and develop the application. The authors recommended Grid computing to the management at this stage and also designed the grid for implementation.

The application's execution used the concepts of meta-computing (Larry and Charlie, 1992) for utilizing the system resources in a network. The growth of the internet and networking has extended the meta-computing concepts to what is known today as grid computing (Ian and Carl, 1999). Studies have shown the importance of Grid computing in shaping the future of IT. There were several frameworks for implementing Grid Computing, but literature had shown strong support for the usage of Microsoft Windows-based grid infrastructure in the adoption of grids (Anderson *et al*., 2002). This was one of the reasons for choosing a .NET based framework in this study.

The Grid application involved substantial computing resources, and the output was directly relevant to the institute. Though the motivation behind implementing Grid Computing was to reduce environmental impact, the institute was also interested in obtaining time savings by executing the Grid application. This involved finding the optimal number of grid computing nodes for a given workload (Nanath, 2011). Therefore, an efficient design for grid computing was established to obtain savings in the execution time.

5.3 Grid computing implementation results

As already mentioned, the implementation was executed in different phases. Phase I (benchmarking) revealed alarming results in terms of the institute's environmental impact under study. The power consumption, cost, and carbon emissions (reported in Table-6) present an accurate picture of IT's negative impact on the environment. Further, Phase II (pilot study) revealed that the systems were under-utilized most of the time. Systems were running idle for more than sixty percent of its runtime (Table-8). The results convinced the administrators to implement Grid Computing in the institute's computer center, thus leading to Phase III of the implementation.

Phase III had considerable benefits for the computer center. It utilized the idle system resources on the network and led to considerable savings in the execution time of the application. Some investment was required to set up the grid architecture and modify the existing application for use in the grid. The investment came in the form of financial resources, human resources, and time. Post-implementation results were used to explore the return on investment. The application hosted on the grid demonstrated lower execution times when compared to standalone execution. Since the application had direct relevance to the institute's business, it turned out to be an added advantage for the organization. Further, the institute could save on new server costs that would otherwise be required to host the application. It also resulted in the improvement of system utilization, increasing the efficiency of the computing resources.

6   DISCUSSION

The outcome of the coding process revealed three broad categories within which the transcribed data could be analyzed. The three categories were: 'Need' for Green IT implementation, 'Scope' of Green IT adoption, and the 'Inclination' to adopt Green IT. Each category was further analyzed to understand the codes that emerged in each dimension. Each dimension included a mix of individual-level and organizational-level factors to provide a multi-level research perspective in the proposed framework. The nature of the dimensions also allowed the exploration of both individual and organizational level factors to support need, scope, and the inclination for Green IT implementation. The three dimensions are discussed ahead.

6.1 Need for Green IT implementation

This dimension includes factors at both individual and organizational levels that could define the need for an organization to implement Green IT. The demonstration of underutilized resources in this case study revealed Grid computing's economic benefits and thus became a decisive motivating factor in implementing Green IT. One of the IT administrators said: *If we can host an application on Grid successfully, then the institute can save on the costs associated with hosting it on a new server…There could be indirect savings on the cooling costs of the server.*

However, the organization was also motivated by the fact that not only will Grid Computing give them economic benefits but also contribute to the environment by effectively utilizing the computing resources. They also expressed an interest in promoting Green IT initiatives to the next level if there was considerable interest from the stakeholders. One of the senior IT administrators said: *We can implement Green IT on a larger scale, provided there are enough participation and pressure by the students and faculties.* The external pressures were evident, particularly when the questions of scaling up Green IT were asked. One of the lab's senior administrators said: *Exploring more options in Green IT would depend on several factors. A lot would depend on our vendors and their Green IT compliance and the industry perspective.* The environmental pressures were visible right from the start of the case study. One of the first questions asked by key decision-makers (Operating Officer and IT Admin Head) in the institute was- *Is there any Green IT initiative in other business schools in India?* The absence of the same led to reduced intentions to implement Green IT.

The coding of interview documents from the IT staff led to the classification of need dimension into two heads: economic factors and external environmental pressures. This classification is consistent with the dimensions of corporate sustainability suggested in the literature (Elkington, 1997). Economic motivation factors refer to the factors that demonstrate direct or indirect cost savings associated with Green IT. In Grid computing, the cost savings on the new server and effective utilization of the computing resources turned out to be the economic motivators for its implementation.

On the other hand, external environmental pressures refer to the external pressures from various stakeholders of the organization like the government, vendors, clients, and competitors. This set of factors could be viewed from the Environment dimension of the TOE framework. Literature has shown the importance of environmental factors and regulatory support in affecting

innovations' diffusion (Zhu and Kraemer, 2005). The government plays a vital role in the implementation levels of Green IT by introducing laws and legislations. Further, the lack of competitive pressure felt by the firms if their competitors do not implement Green IT might lower the motivation for the adoption of Green IT. Competition could drive organizations to initiate and adopt innovations to maintain a competitive edge (Bose and Luo, 2011). All the factors in the participatory case study under the two heads are listed in Table-9. The coding of these factors used the theoretical lens provided by Molla (2009) to increase the generalizability.

<<Insert Table-9 here>>

6.2 Scope of Green IT adoption

The scope of Green IT adoption refers to the opportunity or possibility of an organization to adopt Green IT. Since the case study followed a participatory approach, the interview questions were modified in each phase of the case study based on the feedback from the previous one. Due to the initial reluctance in the implementation of Green IT, Phase II and Phase III involved questions that could understand participants' issues and reluctance in early phases. Based on the coding of the interview answers, the majority of them could be categorized in this domain of Green IT adoption scope. Again, the factors within this domain are a mix of individual and organizational-level factors contributing to the multi-level research.

The concern of business value being not apparent was one of the prominent challenges visible from the data analysis. One of the senior managers reported the following: *We understand that there are many Green IT technologies available, but we are not sure about the adaptability of these technologies with our organization, and the exact business value we could obtain…Sometimes too much choice can be harmful, as all that one gets out of it is confusion.* Further, before the implementation of Grid computing in Phase III, the organization requested to provide a detailed financial breakup of the setup cost. Though the implementation of Grid computing was to be performed using open-source frameworks, the institute would incur other costs related to hosting the application on Grid. This cost was then mapped to the maturity of these technologies in the industry as the IT Admin head asked: *Is the technology being implemented mature enough to justify the cost of implementation?* Therefore, the maturity of platforms in the Green IT industry and business value of Green IT (technological factors) turned out to be

significant factors that could influence the implementation and affect the intention to practice Green IT.

The literature has shown the relevance of *technological context* in the corporate sustainability of a firm. Several studies have shown that the uniqueness of technological IT resources can be a source of sustainability (McFarian, 1984). Further, technical capability can be a potential facilitator (King and Grover, 1991) in delivering competitive advantage to firms by implementing Green IT initiatives. Sachs and Huizinga (1987) suggest that the absence of technological resources could negatively affect the capability to acquire eco-friendly technologies. Organizations with substantial technological assets typically run high-density servers and feel the need to reduce associated power and energy. This might lead to the adoption of Green IT technologies like virtualization (Mitchell, 2008). Misra and Mondal (2011) suggest that such firms might not attain the return on investment as there is an associated cost with the implementation of technologies in green IT.

Organizational factors from the perspective of the TOE framework were also evident from the coding exercise. Even after the institute decided to implement Green IT, they were still hesitant to execute it to perfection. It could be due to the lack of Green IT knowledge. Further, they also wanted to implement some of the Green IT initiatives suggested in the Green IT strategy provided in Phase II. However, the absence of a Green IT implementation team and lack of training in technologies like cloud computing and virtualization led to a delay in initiating the process. One of the comments given by a senior IT administrator was: *Even if I initiated some Green IT practices, it would rest upon the top management team to support and drive this….We are not sure if we have enough skills in the current team to go beyond Grid computing.* Therefore, factors like lack of top management support, inadequate skills and training in Green IT, and the absence of a Green IT team potentially affected the intentions to participate in Green IT practices.

Previous studies have shown the relevance of *organizational context* in the sustainability initiatives of an organization (TOE framework). Studies have shown that organizational factors might explain the differences in IT adoption's extent and speed (Camara *et al*., 2004). Top management support is influential in modifying old structures and preparing an organization for a change (Purcell and Ahlstrand, 1994) by creating a strategic vision. Adoption of Green IT requires significant change management, and lack of management support could lead to unsuccessful

organizational operations (Roberts *et al.*, 2003). It has also been emphasized that the employees should possess enough skills to work with Green IT technologies. The lack of training and skills leads to decreased motivation in implementing Green IT in an organization (Molla, 2009). Further, organizations must possess enough financial resources to initiate the implementation of Green IT. Literature for IS adoption has shown that financial resources are essential antecedents to IS diffusion (Zhu and Kraemer, 2005). Implementation of Green IT involves investment in hardware, software, employee training, and system maintenance. Therefore, the TOE framework provided a robust theoretical lens to list the factors that could influence the Green IT implementation scope, and they are summarized in Table 10.

<<Insert Table-10 here>>

6.3 Inclination to adopt Green IT

The inclination of a firm in adopting Green IT refers to the organization's tendency or urge to act upon Green IT adoption. The IT administrators in the organization were initially skeptical about the implementation of Grid Computing at the computing center. However, after Phase II of the study, they were excited to see the computer center's environmental impact and resource utilization. One of the administrators expressed his concern over the issue and said, *"These statistics (underutilization, power consumption and carbon emissions) reveal an important aspect of IT and sustainability, which needs serious consideration at the institute."* Several administrators and IT managers developed a positive attitude towards implementing Green IT after the economic benefits of Grid Computing were shown. One of the senior managers reported: *We should go ahead with the Grid computing implementation. In fact, this would be the first step towards Green IT…We strongly recommend the implementation of other Green IT initiatives reported in the document…Implementing Green IT initiatives will be a pleasurable and enjoyable experience.* This captures the different aspects of the individual attitude proposed by Ajzen (1991). Therefore individual attitude (particularly in top management) could play an essential role in developing an intention to practice Green IT infinitives.

Further, it was evident that few IT administrators were concerned about Green IT practices, followed by their sister business school peers. Comments by several administrators brought up the importance of subjective norm: *Do the administrators in other campuses of our business school*

implement Green IT? ...I am ready to go ahead with the Green Computing implementation, but will the other administrators support the idea? It could be seen that critical decision-makers in the organization think about the people in their network regarding the practices of Green IT implementation. This strengthens the role of the subjective norm in shaping up the intention to practice Green IT.

The IT department staff were deeply involved in the implementation of Grid computing, along with the authors. Some of them dedicated time even after the working hours, and when asked regarding the incentives of dedication, one of them commented: *As a responsible employee of an organization, the responsibility also translates to the commitment for sustainability...If new initiatives make computing more efficient and environment friendly, then I am ready to dedicate more time.* This reflected the employees' environmental consideration as part of the ethical motivation factor that could positively influence the drive for implementing Green IT.

The literature and theoretical lens selected in this study also indicate the importance of defining the 'Inclination' towards Green IT implementation. Studies have recommended that a culture of sustainability be embedded deep in the organizational structure and encompass all the firm members (Shrivastava, 1995). It is possible only when individuals in an organization possess a positive attitude towards practicing Green initiatives. It requires individuals to replace short-term perspective with an intergenerational time frame to embrace spirituality, morality, and smallness (Stead and Stead, 1992). TRA further states that an individual's conscious belief and behavior depends upon his/her intention to perform a given action. The intention is, in turn, influenced by two factors: attitude (favorable/ non-favorable) and subjective norms. Chow and Chen (2009) have demonstrated the impact of individual-level factors on the Green IT adoption in the context of a developing country. Based on the participatory case study data, three factors proposed in the individual-level analysis turned out to be significant- Individual attitude, Subjective Norm, and Ethical motivation factor (environmental consideration).

Based on the summary of all levels, three dominant themes were discussed: Need, Scope, and Inclination for Green IT implementation. These factors affect the intention to practice Green IT that further was reflected in the actual Green IT behavior. The link of intention and actual behavior is well documented in the Theory of Reasoned Action (and TPB). A summary of this proposed framework is given in Figure-1.

<<Insert Figure-1 here>>

7   CONCLUSION

The framework proposed by this research adds to the body of literature that explores the adoption of Green IT in developing countries. While drawing upon factors from available Green IT frameworks like Molla (2008) and Bose and Luo (2011), this research introduces a multi-level agenda of individual and organizational parameters that affect Green IT implementation. Further, the Indian context in this research provides the less discussed Green IT context in developing countries. While studies have emphasized the importance of Green IT discussion in developing countries due to the challenges (Hardin-Ramanan and Chang, 2018), the actual research is scarce.

The case study analysis revealed factors consistent with the literature and theory, but new dimensions emerged that could explain the adoption issues in developing countries. Each dimension in the proposed framework (Need, Scope, and Inclination) could be rated High or Low by reviewing the factors within the dimension. For example, high external pressures might influence the need for Green IT implementation. However, if the scope of Green IT implementation is low, then the organization might not find an effective Green IT solution. Alternatively, if the implementation scope is high, but there is a lack of external pressure and economic motivation, organizations might ignore the overall proposal of adoption or scaling up Green IT operations. However, a large scale in all three dimensions of need, scope, and inclination could make the organization move to a higher-order Green IT adoption. Future research could explore the scale development in these dimensions to assess the maturity and future of Green IT implementation.

The research can lead to implications in theory and practice. In terms of theoretical implications, the findings confirm those previous studies on Green IT adoption that have worked on an individual and organizational level in silos. However, the proposed model takes up the multi-level approach on Green IT that has not been explored well in the literature. The participatory case study allows the research to be based on the chosen theoretical lens but allows the researchers to get insights into factors that emerge from the data analysis. The practical implications of this research could be important for managers who wish to implement Green IT, particularly in the

context of developing countries. It could allow the decision-makers to be aware of both the individual and organizational factors that could facilitate and inhibit implementation and adoption.

Since this study is exploratory, there are some limitations as well. The case study involves the implementation of Grid Computing, which is one of the potential Green IT solutions (Vykoukal *et al.*, 2009). Based on the review of Green IT studies (Singh and Sahu, 2020), there are other prominent technologies like virtualization, cloud computing, green apps, sensor technology, energy management systems, and others. However, the case study's discussion and implications could be restricted to Grid Computing and thus possibly reducing the scope of generalizability. Further, the organization under study is a business school (education sector), and hence the perspectives could change when implemented in other sectors. Further, the participatory approach is very sensitive to stakeholder needs versus research needs. There could be a bias in the definition of project success as authors were involved in design and implementation. The analysis, though involved independent coders, was not wholly different from the case study actors due to author participation. This could lead to analysis results coming from the author lens and hence could reduce the generalizability of results.

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TABLES AND FIGURES USED IN THE MANUSCRIPT

Table-1: Studies in Green IT adoption at an organizational level

Organizational Level		
Category	Description	Study
Leadership	Support from the top management for implementing Green IT	Hernandez (2020); Jenkin *et al.* (2011); Molla *et al.* (2009)
Organizational Culture and structure	Sustainability culture in an organization.	Bose and Luo (2011); Chen and Chang (2014); Moini *et al.* (2014)
Firm Size	Larger size and hence more resources for adopting Green IT.	Khor *et al.* (2015); Moini *et al.* (2014).
Regulatory Compliance	Organizations following the sustainability regulations.	Bose and Luo (2011); Molla and Abareshi (2011); Thomson and van Belle (2015)
Technological Resources	Scalability, reliability and energy efficient designs.	Kapoor *et al.* (2014);

Table-2: Studies in Green IT adoption at an individual level

Individual Level		
Category	Description	Study
Self-Motivation	Individual drive to follow Green IT practices.	Raisinghani and Idemudia (2019); Shevchuk and Oinas-Kukkonen (2019)
Individual Social Responsibility	Drive to consider Green IT practices as social responsibility	Bose and Luo (2011); Ozturk *et al.* (2011); Raisinghani and Idemudia (2019);
Individual attitude and perception		Koo and Chung (2014); Schmermbeck (2019); Wang *et al.* (2015)
Knowledge	Individual understanding of Green IT and its benefits.	Etzion (2007); Yahya *et al.* (2014)
Individual ethical drivers	Sustainable and normatively good behaviors that seek social, global, and local recognition.	Karanasios *et al.* (2010); Molla (2008)

Table-3: Evaluation of technology adoption theories for Green IT in developing countries

Theory	Main Author(s)	Unit of Analysis	Context of sustainability in developing countries	Usage in the context of Green IT (top IS journals)
Theory of Reasoned Action	Fishbein and Ajzen (1975)	Ind.	Yes (Paul *et al*., 2016)	Yes (Mishra *et al*., 2014)
Theory of Planned Behavior	Ajzen (1991)	Ind.		Yes (Koo and Chung, 2014)
Technology Acceptance Model	Davis (1989)	Ind.	No	Yes (Akman and Mishra, 2015)
Technology, Organization, and Environment	Tornatzky *et al*. (1990)	Org.	Yes (Angeles, 2012)	Yes (Bose and Luo, 2011)
Unified Theory of Acceptance and Use of Technology	Venkatesh *et al*. (2003)	Ind.	Yes (Khorasanizadeh *et al*., 2016)	No
Technology Acceptance Model II	Venkatesh *et al*. (2003)	Ind.	No	No
Diffusion/Implementation Model	Kwon and Zmud (1987)	Org.	No	No

Table-4: Interview Participants and their backgrounds

Category	Position	Level	Number	Phase
Internal /IT	Head IT Administrator	Senior Manager	1	Phase I and III
Internal /IT	IT Administrator	Manager	2	Phase I, II, and III
Internal / IT	IT Staff	Staff	2	Phase II and III
Internal /Non-IT	Chief Operating Officer	Senior Executive	1	Phase I
Author 1	n/a	n/a	1	Phase I, II, and III

Author 2	n/a	n/a	1	Phase I
External	IT consultant	Manager	1	Phase 1
External	Academic Researcher	n/a	1	Phase I, II, and II

Table 5: Inputs for Microsoft Desktop Energy Savings Calculator

Desktop Energy Estimates: Inputs	
Number of PCs	500
LCD Usage	76%
CRT Usage	24%
Desktops	100%
Notebooks	0
Windows XP	77%
Windows Vista	3%
Other Windows	21%

Table 6: Output, Annual Consumption of the business school

Desktop Energy Estimates: Output	
Power Cost	$ 46, 278 per year
Power Consumed	473, 676 KW/h
Carbon Emissions	367.1 tons
Equivalent number of automobiles	67.2
Equivalent number of homes	39.4
Equivalent number of trees	797.7

Table 7: Idle Time recording of a sample user	Table 8: Results of the study, Phase II

Start Time 1:17:38 AM
End Time   9:47:14 AM

Idle Count	Idle Time
1	30.05
2	64.58
3	47.05
4	94.61
5	187.56
6	23804.91
7	5833.7

No. of Sample Cases	25
Total idle count (per hour, across samples)	135
Average idle count/h	5.4
The average percentage of time the system remained idle	57.78%

Table 9: Need to implement Green IT

ECONOMIC MOTIVATION FACTORS
IT cost reduction considerations
The cost of greening IT
EXTERNAL ENVIRONMENTAL PRESSURES
Green IT uptake by competitors
Clients' /consumers' pressure
Industry associations
Pressure from IT vendors
Competitors' actions and extent of Green IT adoption in the industry

Table 10: Scope of Green IT adoption

TECHNOLOGICAL FACTORS
Maturity of platforms in the Green IT industry
Unclear business value in greening IT
ORGANIZATION FACTORS
Lack of business leadership on Green IT
The extent of IT sophistication in the organization
Inadequate skills and training

Need for Green IT implementation

Economic Motivation factors
External Environmental pressures.

Scope of Green IT implementation

Technological Factors
Organizational Factors

Inclination to adopt Green IT

Individual attitude
Subjective Norm
Ethical motivation factor
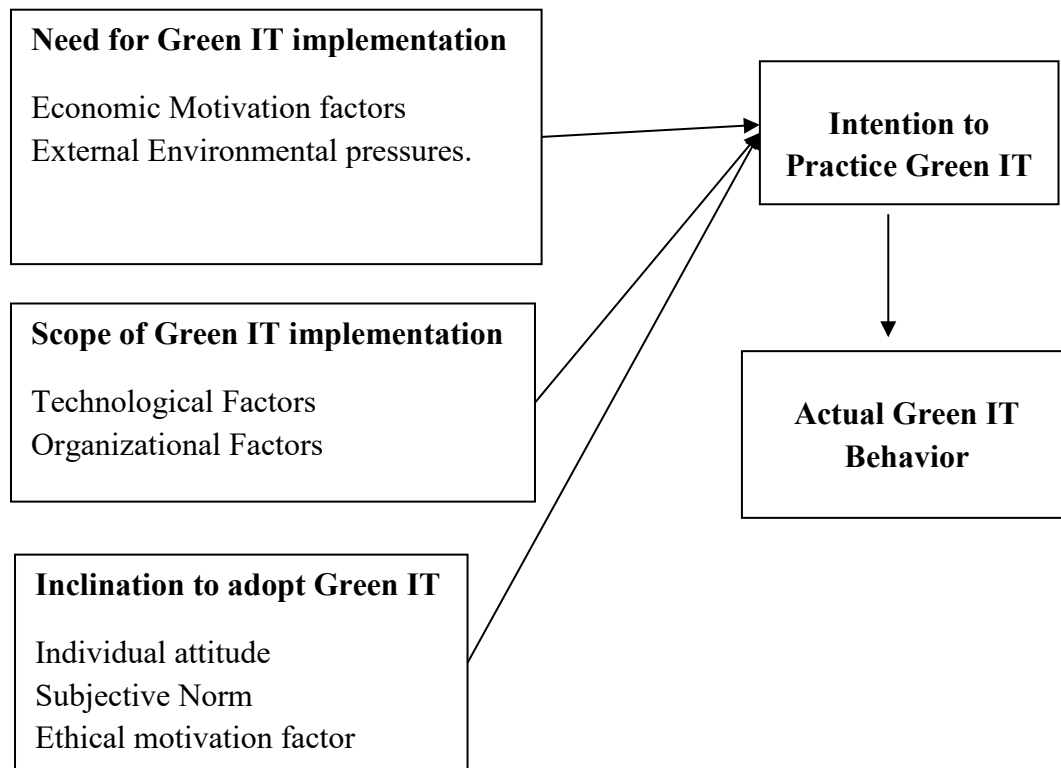
Intention to Practice Green IT

Actual Green IT Behavior

Figure 1: Framework for Green IT implementation.