Green Computing Adoption: Understanding the Role of Individual, Social, and Organizational Factors

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Abstract: This study investigates the factors influencing the attitudes of software developers and IT professionals towards Green Information Technology (GIT) in Bangladeshi IT/software firms and examines their impact on engagement in green computing practices. Data was collected from 130 participants. A thorough literature review was conducted. The findings highlight key individual factors that influence employees' attitudes, including awareness, knowledge, and perception of environmental issues. The study demonstrates the connection with GIT attitudes and behavior modification, especially through stated usage of green computing methods. Data analysis confirms 5 out of 8 hypotheses and reveals the complexity of the relationships between the constructs. The report promotes the adoption of Green IT technology by software companies in Bangladesh and highlights the significance of an organized office system integrating Green IT. Limitations include a relatively small sample size and the multidimensional nature of the relationships between the constructs. The findings can assist software companies in addressing customer concerns about the performance and functionality of green computing practices, ultimately promoting sustainable computing practices in the IT sector of Bangladesh.

1 INTRODUCTION

Green growth strategy that seeks to increase performance and productivity by fostering resource consumption and output that is sustainable within companies and society is known as green information technology (GIT) (Gazzola et al., 2019), (Przychodzen et al., 2018). Green IT provides more effective resource management by maximizing resource use, decreasing waste and emissions, and improving recycling rates. However, because of the low sturdiness of IT devices and specific production and disposal processes, worries about negative effects have emerged, such as increased electricity usage by companies (Asadi et al., 2019). Additionally, the carbon footprint of IT hardware and software is greater than even the waste produced by the aviation sector (Asadi et al., 2019), (Mishra et al., 2014). The growing need for sustainable practices in the production and use of IT has prompted the development of the field of Green IT within the fields of computer science and information systems (Jenkin et al., 2011), (Melville, 2010).

Given the prevalent trend of industrial processes over-shadowing their environmental impact, green purchase intention" refers to the tendency and readiness of consumers who prioritize environmental and ethical issues to choose environmentally friendly items instead of conventional ones. Green IT aims to reduce the indirect ecological effects of IT operations through environmentally responsible PC design, manufacturing, use, and disposal. Governments and the public are putting increasing pressure on businesses to reduce their ecological footprint (Paillé et al., 2014), (Zibarras and Coan, 2015). From the perspective of Bangladesh, Lack of awareness or knowledge about green computing among potential customers can make it challenging for software companies to market their products or services. If potential customers do not understand the benefits of green

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computing, they may be less likely to invest in software that supports sustainable computing practices (Ojo et al., 2019). Many software companies may not have the expertise or resources necessary to develop and market green computing practices. This can limit their ability to compete with other companies that have more experience in this area. Companies may use claims of environmentally friendly software development practices as a marketing tactic, without making substantial changes to their processes. This could lead to a loss of trust and credibility among consumers who are becoming increasingly aware of green washing tactics (Ojo et al., 2019).

Finally, some companies may be resistant to change and may be hesitant to adopt new technologies and practices. This can make it difficult for software companies to promote green computing practices and gain traction in the market. In some cases, there may be a perception among customers that green computing practices come at the expense of performance or functionality. Software companies may need to address these concerns through effective marketing and communication to ensure that potential customers understand the benefits of green computing initiatives. Based on the current situation of Bangladesh, three research questions were presented:

1. **What factors influence employees attitudes towards GIT, and how do these attitudes impact their engagement in green computing?**
2. **How does the organizational culture of green management influence employees attitudes towards GIT and their engagement in green computing?**
3. **To what extent does social influence play a role in shaping employees attitudes towards GIT, and how does this affect their engagement in green computing?**

To better understand how software developers and IT professionals views about Green Information Technology in Bangladeshi IT/software organizations, this study will look at the influence of people, community, and organizational variables. Additionally, it investigates how their views about GIT play a moderating function in this relationship. The study looks specifically at stated participation in environmentally friendly computing practices to examine the relationship between GIT attitudes and alterations in behavior. 130 participants completed a survey that was used to collect the data, and a thorough evaluation of the literature was done with an emphasis on pertinent studies carried out by well-known writers in other nations. The main goal is to Investigate the key individual factors that influence employees attitudes towards GIT, such as awareness, knowledge, and perception of environmental issues, and examine how these attitudes impact their engagement in green computing practices.

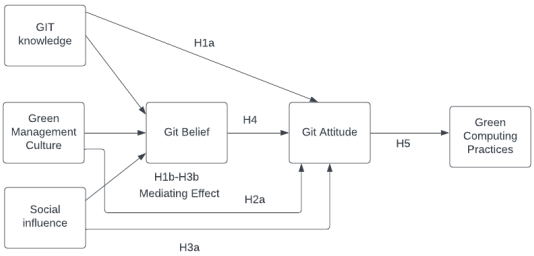

Figure 1: Research Model that shows the relation between the variables and how they shape Green Computing Practices.

This paper will contribute to the country's adoption of Green IT technology in software companies and IT companies in the long run by helping them to adopt a structured office system involving Green IT.

2 RESEARCH MODEL AND HYPOTHESIS

This research builds upon the study conducted by Ojo, A. O., and colleagues. In their paper, they presented a comprehensive data model, depicted in Figure 1 (Ojo et al., 2019). The model is rooted in the Belief-Action- Outcome (BAO) framework, originally proposed by Melville in 2010 (Melville, 2010). The BAO framework suggests that GIT knowledge, Green Management Culture, and social influence have an impact on Git belief, which in turn influences GIT Attitude. Ultimately, all these factors collectively shape the Green Computing Practices of IT companies.

2.1 Effect of GIT Knowledge on GIT Belief and Attitude

Understanding how things work in both general and specific contexts begins with knowledge. Individuals' acceptance of a specific phenomenon in their minds is included in belief. When a belief is accepted personally, it takes on permanent worth and inspires people to behave in line with it (Koo and Chung, 2014), (Xenitidou and Edmonds, 2014). Individuals can obtain the necessary knowledge to embrace and embrace environmentally friendly beliefs and attitudes by participating in training, education, or gaining experience in environmental matters (Chou, 2014). As a result, accessing information that supports pro-environmental principles allows individuals to culti-

vate environmentally conscious thoughts and actions.

- **H1a. The level of employees GIT knowledge is positively associated with their attitude towards GIT.**
- **H1b. The influence of employees GIT knowledge on their attitude towards GIT is mediated by their GIT belief.**

2.2 Effect of Green Management Culture on GIT Belief and Attitude

Having an understanding of the organizational culture enables employees to identify the appropriate norms and working practices that are endorsed by the company (Quan and Cha, 2010). By establishing clear expectations regarding what is valued and how tasks should be accomplished, the culture sets guidelines for acceptable behavior and influences the choices made by employees. It is crucial for the organization to align its values and expectation with environmental sustainability and grant employees the freedom to engage in ecofriendly activities, fostering a supportive environment. The organizational culture can either facilitate or hinder employee commitment to green initiatives (Govindarajulu and Daily, 2004), (Rothenberg, 2003).

- **H2a. There is a positive correlation between Green Management culture and employees attitude towards GIT.**
- **H2b. The impact of Green Management culture on employees attitude towards GIT is mediated by GIT belief**.

2.3 Social Effect on GIT Belief and Attitude

Research findings indicate that social factors play a role in shaping users attitudes, intentions, and perceptions regarding the utility of technology. The influence of social elements has predominantly been linked to users attitudes and intentions (Lewis et al., 2003), (Venkatesh et al., 2003).

- **H3a. There is a positive correlation between social influence and employees attitude towards GIT.**
- **H3b. The impact of social influence on employees attitude towards GIT is mediated by GIT belief.**

2.3.1 GIT Belief and Attitude

Employees perceptions of green information technology (GIT) mirror their cognitive understanding of GIT's capabilities and their recognition of the importance of adhering to environmentally friendly workplace IT practices (Molla et al., 2011).

- **H4. There is a positive correlation between employees GIT belief and their attitude towards GIT.**

2.4 GIT Attitude and Green Computing Practices

By implementing their own environmentally conscious computing practices, such as turning off computers when idle, IT staff members can support the company's waste reduction and sustainability programs. Employees' attitudes towards green computing demonstrate their dedication to assuming responsibility for environmentally conscious IT equipment usage in the workplace (Ojo et al., 2019).

- **H5. There is a positive association between employees' attitude towards GIT and their active participation in green computing practices.**

3 METHODOLOGY

The data was collected from software developers and IT officials from the software development and IT companies of Bangladesh. The samples were chosen randomly and a list of 12 companies was created. Using the G-Power tool, the test group size was determined. To calculate test family F testes and linear multiple regression was chosen and number of predictors 4 was input. G-power returned a total sample size of 129. The google survey questionnaire links were sent through emails to the companies seeking participation. Respondent identity was not collected to ensure anonymity. The questionnaires were taken from the works of Ojo, A. O., et al (Ojo et al., 2019). Each issue was assessed using a Likert scale. After collecting the data, responses with incomplete or missing data were excluded. The rest of the data was converted to ordinal value and analysed In SmartPLS-4 shown in Figure 2. For algorithm PLS-SEM algorithm and Bootstrapping was applied.

Along with the survey this research also conducted extensive literature review on pre-existing work of other renowned author's publications in other countries and the review is added to this paper.

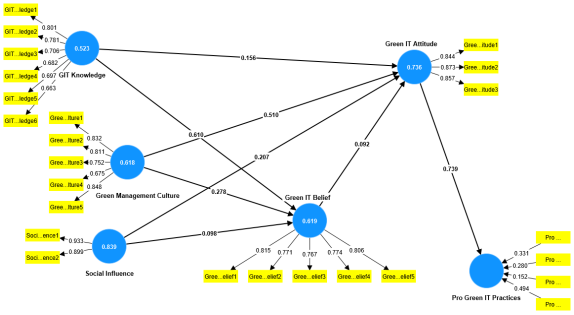

Figure 2: SmartPLS design created based on the research model in Figure 1, showing the loading values and relations.

4 RELATED LITERATURE REVIEW

The literature review examines several empirical studies focused on investigating various aspects of green computing practices among IT professionals in different countries, including Malaysia, Bangladesh, and India. The studies explore the factors influencing green computing behaviours and practices, such as green beliefs, attitudes, environmental awareness, green IT consciousness, and perceived organizational support.

The study by Ojo, Raman, and Downe (Ojo et al., 2019) in Malaysia reveals a direct correlation between higher levels of green beliefs and direct attitudes towards green computing practices between IT officials. Similarly, Molla, Abareshi, and Cooper (Molla et al., 2014) find that stronger green IT beliefs are positively correlated with higher levels of pro-environmental IT practices among IT professionals. The role of green IT/IS innovation in promoting sustainability practices and environmental conservation is highlighted in the study by Jnr (Jnr, 2020) in an emerging economy. Hossain, San, Ling, and Said (Hossain et al., 2020) in Bangladesh reveal that higher levels of environmental awareness and green technological usage are associated with increased adoption of sustainable green practices among manufacturing SMEs.

Ojo et al. (2018) investigate the cognitive influences on perceptions and attitudes about environmentally friendly information technology and organizational factors and barriers affecting green computing practices (Ojo et al., 2018). Tan et al. (Tan et al., 2019) examine the determinants of green computing adoption, while Ong, Lim, and Lim (2019) and Chew, Yong, and Ng (Ng and Ng, 2019)) analyze the influence of organizational culture and environmental concern on green computing practices, respectively. Zhou, Liang, and Huang (Zhou et al., 2020) study the mediating role of environmental awareness in the relationship between perceived organizational support and green computing practices.

Bhatti analyze the influence of integrate organizational and innovative environmental behavior on green computing practices, respectively (Bhatti et al., 2021). Ramli's study investigates the factors influencing Green IT adoption in Malaysia through qualitative methods, identifying environmental, cost, organizational, technological, and business opportunity factors, aiming to support Malaysia's goal of reducing greenhouse gas emissions (Ramli et al., 2021).

Furthermore, Kaur, Yadav, and Singh (Kour et al., 2020) focus on the role of green IT consciousness in influencing green computing practices among IT professionals in India. Syzdykbayeva highlights the growing importance of green computing in response to energy costs, global warming concerns, and regulatory pressures, particularly in Malaysian companies (Syzdykbayeva, 2009), while Buisson discusses a study investigating the low awareness and practice of green computing among IT workers, emphasizing the need for environmental awareness initiatives to promote green computing behaviors (du Buisson and Naidoo, 2014). Paille et al. conducted an investigation on the effects of HRM (human resource management) on the environment at the workforce sector (Paillé et al., 2014). Zibarras and Coan (Zibarras and Coan, 2015) surveyed UK organizations to identify HRM procedures are utilized to encourage environmentally friendly behavior.

Gazzola discussed the trade-offs between going green and going smart for sustainable development (Gazzola et al., 2019), while Przychodzen et al. investigated the relationship between green information technology (IT) practices and financial performance (Przychodzen et al., 2018). Perkins et al. highlighted the global hazard of e-waste (Perkins et al., 2014), and Asadi and Dahlan conducted a systematic literature review to identify research on Green IT in organizational contexts from 2007 to 2016 (Asadi et al., 2017). Mishra et al. (Mishra et al., 2014) applied the Theory of Reasoned Action to investigate the factors that influence the acceptance of Green IT among employees, and Jenkin et al. proposed an agenda for Green IT and systems research (Jenkin et al., 2011).

Melville explored how technological development could contribute to ecological preservation. and identified several areas where information systems can contribute to environmental sustainability, such as energy management, supply chain management, and sustainable product design (Melville, 2010). Asadi et al. analyzed the impacts of green manufacturing and technology innovations on sustainable development (Asadi et al., 2021), and Sharma

Table 1: Demographic of the Respondent.

Measure	Items	Responses	Responses (%)
Education	CSE, EEE, Self-taught	113, 15, 2	87%, 12%, 2%
Project	IT Support, Mobile App, Database Management, Web Development, Software Development	4, 8, 11, 90, 17	3%, 6%, 8%, 69%, 13%
Experience	0-2, 2-5, 5-10, 10+ Years	71, 50, 6, 3	55%, 38%, 5%, 2%
Company Size	Midsize, Startup, Large Corporation	61, 60, 9	47%, 46%, 7%

Table 2: AVE and CR.

Measure	Composite Reliability	Average Variance Extracted(AVE)
GIT Belief	0.89	0.619
GIT Knowledge	0.868	0.523
Green IT Attitude	0.893	0.736
Green Management Culture	0.889	0.618
Social Influence	0.913	0.839

et al. provided a strategy for the implementation of environmentally friendly information technology in manufacturing enterprises (Sharma et al., 2022). Meidute-Kavaliauskiene et al. researched the implications of open innovation for green invention in complicated environmental environments (Meidute-Kavaliauskiene et al., 2021), and Kour et al. investigated the effect of green practices on the financial performance of Indian automobile businesses (Kour et al., 2020). The limiting influence of IT capability in the connection between green innovation and business sustainable development was also investigated by Li et al. (Li et al., 2022). Therefore, the literature review on green computing practices among IT professionals identifies gaps in research, including limited studies in developing countries, a lack of focus on specific IT professional roles, and the need for comparative and longitudinal studies. Additionally, there is a limited exploration of technological solutions and a lack of emphasis on the outcomes and impacts of green computing practices.

Overall, the literature review highlights the importance of various factors, including green beliefs, attitudes, environmental awareness, green IT consciousness, and perceived organizational support, in shaping green computing behaviours and practices among IT professionals in different countries. The findings from these empirical studies provide valuable insights for understanding the complex dynamics and challenges associated with green computing practices in the field of Information Technology.

5 DATA AND RESULT ANALYSIS

5.1 Validation of Measurement Model

130 individuals in total took part in the research, and table 1 shows some demographic information about them. The majority of the respondents (approximately 86%) have a background in Computer Science Education, while 12% come from an Electrical Engineering background, and 2% are self taught. In terms of employment, the respondents are mainly engaged in various IT related roles, including IT support, Mobile app development, Database management, Web Development, and Software Engineering. Regarding their professional experience, according to the findings, 38% of those surveyed have 2–5 years of expertise, compared to 0–2 years for 55% of respondents. 5 percent of respondents said they had five to ten years of expertise, and 2 percent said they had more than ten years.

Overall, the findings indicate that the sample consists predominantly of individuals with a background in Computer Science Education, working in diverse IT roles, and varying levels of professional experience. When analyzing the study's findings, these aspects must be kept in mind.

In order to evaluate the convergent and discriminant validity of the reflective variables, several assessments were conducted. Convergent validity was evaluated based on factor loadings shown in Table 3, and CR and AVE shown in Table 2.

To evaluate discriminant validity, the correlations between variables were compared with the square root of the average variance extracted (AVE) for the respective variables. The results, as presented in Table 2, indicate that all constructs met the cut-off criteria. This means that the AVE values were greater than 0.5, and the CR values exceeded 0.7, indicating good internal consistency. Additionally, the CR values were greater than the AVE values, further supporting the discriminant validity of the constructs.

5.2 Hypotheses Testing

The proposed relationships between variables were investigated by analyzing the structural model (Fig. 1). Beta (β) coefficients were computed based on

Table 3: Measurement Scales (Factor Loading).

Construct	Measurement Items	Loadings
GIT Knowledge	I know about Green IT (e.g., energy efficient device, thin client, cloud computing)	0.801
	I concur that opting for Green IT represents an individual choice or option	0.781
	I agree that green energy has the potential to serve as a replacement for fossil fuel energy sources (such as oil and gas) as well as nuclear power	0.706
	I agree that using Green IT device can affect my company's electricity bill	0.682
	I agree about that Green IT is reliable and secure	0.697
	I get enough information about programs to promote Green IT	0.663
Green IT Attitude	I feel that green computing is a convenient thing for me to practice in the workplace	0.893
	I feel that green computing is a good thing for me to practice in the workplace	0.873
	I feel that green computing is a pleasant thing for me to practice in the workplace	0.857
GIT Belief	I believe that IT equipment and systems contribute to greenhouse gas emissions	0.815
	I believe that IT personnel should be responsible for reducing IT's greenhouse gas emissions	0.771
	I believe IT can be used to reduce a business's total carbon footprint (i.e., emission of carbon dioxide)	0.767
	I believe that IT professionals have the ability to make substantial contributions towards assisting businesses in addressing their carbon footprint, which refers to the emission of carbon dioxide	0.774
	I believe that tackling the carbon footprint of IT systems should be a core part of the green business	0.806
Green Management Culture	Our top management actively advocates for and supports the implementation of environmentally conscious practices	0.832
	Environmental considerations are integral to our organization's vision and mission statements	0.811
	Our top management effectively disseminates information and promotes the importance of environmental management across the organization	0.752
	Our top management establishes a system of punishments and penalties to enforce compliance with environmental management policies	0.675
	Our team/department budgets are allocated to address and mitigate our environmental impact	0.848
Pro Green IT Practices	I make use of the power-saving features available on the IT devices I regularly use	0.818
	I ensure to turn off my computer when it is not being used	0.717
	I choose to purchase IT equipment that has been recycled for my personal use	0.682
	I actively practice double-sided printing to minimize paper waste	0.86
Social Influence	People who exert influence over my behavior strongly advocate for the adoption of Green IT practices	0.933
	Individuals who hold significant importance in my life emphasize the importance of practicing Green IT	0.899

Table 4: Mean, STDEV, T Values, P Values.

Measurement Items	GIT Belief	GIT Knowledge	Green IT Attitude	Green Management Culture	Social Influence
GIT Belief	0.787				
GIT Knowledge	0.865	0.723			
Green IT Attitude	0.757	0.72	0.858		
Green Management Culture	0.781	0.716	0.834	0.786	
Social Influence	0.637	0.575	0.702	0.679	0.916

the path analysis, and the significance of these coefficients was determined using T Statistics.

Table 2 provides the Composite Reliability (CR) and Average Variance Extracted (AVE) values for each construct in the study. The CR values range from 0.868 to 0.913, indicating good internal consistency reliability, while the AVE values range from 0.523 to 0.839, suggesting satisfactory convergent validity. These values demonstrate the reliability and validity of the measurement scales used in the study.

Table 3 displays the factor loadings for measurement items under each construct. The factor loadings range from 0.663 to 0.933, indicating strong associations between the measurement items and their respective constructs. For example, in the GIT Knowledge construct, the measurement item "I know about Green IT" has a factor loading of 0.801, suggesting a strong relationship between participants' knowledge of Green IT and this construct. Similarly, in the Social Influence construct, the measurement item "People who exert influence over my behavior strongly advocate for the adoption of Green IT practices" has a high factor loading of 0.933, indicating a strong association between social influence and participants' attitudes towards Green IT adoption. Overall, these factor loadings provide evidence of the constructs' validity and reliability in measuring participants' perceptions and behaviors related to Green IT adoption.

Table 4 provides key statistical values for measurement items related to different constructs in the study. The mean scores for GIT Belief, GIT Knowledge, Green IT Attitude, Green Management Culture, and Social Influence are 0.787, 0.865, 0.757, 0.781, and 0.637, respectively. Standard deviations (STDEV) range from 0.575 to 0.723, indicating variability in responses. T values and P values demonstrate the significance of relationships between constructs, with lower P values suggesting stronger evidence for hypotheses. Notably, the P value for Social Influence is 0.91, indicating a higher level of significance compared to other constructs.

Table 5 provides insight into the discriminant va-

Table 5: Discriminant Validity.

Hypothesis	Description	Original sample	T statistics	P values	Comments
H1a	GIT knowledge has a direct impact on Green IT attitude	0.156	1.625	0.104	Not Supported
H1b	The progression from GIT knowledge to GIT belief and its subsequent impact on GIT attitude	0.61	8.513	0	Supported
H2a	Green Management Culture has a direct impact on GIT Attitude	0.51	5.543	0	Supported
H2b	The connection between the culture of Green Management, the belief in GIT, and the subsequent attitude towards GIT	0.278	4.091	0	Supported
H3a	Social Influence has a direct impact on GIT Attitude	0.207	3.275	0.001	Supported
H3b	The influence of social factors on GIT belief and its impact on GIT attitude	0.098	1.867	0.062	Not Supported
H4	GIT Belief has a direct impact on Green IT Attitude	0.092	0.862	0.389	Not Supported
H5	GIT Attitude has a direct impact on Green Computing Practices	0.739	11.114	0	Supported

lidity of the constructs, with diagonal values being higher than the corresponding inner values. However, it is worth noting that two of the inner values were lower than the diagonal values, suggesting some potential overlap between those constructs. It presents the results regarding the support for the hypotheses based on the data. Hypotheses with p-values below 0.05 are considered supported by the data, while hypotheses with p-values above 0.05 are deemed unsupported. Upon analysis, it was found that Hypotheses H1a (0.104), H3b (0.062), and H4 (0.389) had p-values higher than 0.05, indicating that they were not supported by the data. Conversely, Hypotheses H1b, H2a, H2b, H3a, and H5 exhibited p-values below 0.05, meeting the expected criteria and therefore being supported by the data. In conclusion, out of the total of eight hypotheses tested, five were supported by the data, while three were not. These findings provide insights into the relationships between the variables under investigation and offer important implications for the study's overall results.

6 CONCLUSION

This paper tries to highlight the relationship between individual, social, and organizational factors on software developers' and IT professionals' attitudes toward Green Information Technology (GIT) in Bangladeshi IT/software firms. The analysis proved 5 out of the hypotheses were correct. Some of the limitations of this paper are lack of participants. At most only 12 companies were found willing to provide data. Data from more companies could help reach a better representation of the population. The relationship between the constructs are multidimensional and complex. But this paper hopes to help achieve better green adoption policies for Bangladesh. Sometimes customers may have concerns about the performance or functionality of green computing practices (Venkatesh et al., 2003). By investigating the relationship between GIT attitudes and behavioural change, it can provide evidence to alleviate these concerns. Software companies can use these findings in their marketing efforts to assure potential customers that adopting green computing practices does not compromise software performance or functionality.

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