Perceived Ease of Use and Perceived Usefulness as Determinants of Green IT Attitudes and Engagement Green IT Practice for Environmental IT Performance

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Abstract: - This research aimed to explore the effect of Perceived Ease of Use, Perceived Usefulness, GIT Attitudes, and Engagement in Green IT Practice on Environmental IT Performance. This research was carried out individually using an online questionnaire to the 230 employees who work in a logistics company in East Java. Data was analyzed using Structural Equation Modelling (SEM). The results show that Perceived Ease-of-Use has a significant effect on GIT Attitude, Perceived Usefulness has a significant effect on GIT Attitude, GIT Attitude has a significant effect on Engagement in GIT Practice, Engagement in GIT Practice has a significant effect on Environmental IT Performance, and Engagement in GIT Practice has a significant effect as a mediator in influencing the relationship between GIT Attitude and Environmental IT Performance. The novelty of this research is integrating the Technology Acceptance Model and Belief-Action-Outcome Framework as the foundation of the conceptual model. Organizations should actively promote and integrate perceived usefulness, Green IT attitudes, and Green IT practices into their operations to achieve better environmental IT performance.

Key-Words: - Belief Action Outcome, Engagement Green IT Practice, Environmental IT Performance, Green IT Attitudes, Sustainable Technology Adoptio, Sustainable Development, Technology Acceptance Model.

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1 Introduction

Climate change, driven by human activities, is a pressing global challenge with far-reaching impacts on the environment and society, [1], [2]. The UNFCCC, recognizing the need for a coordinated response, emphasizes the principle of "common but differentiated responsibilities" in addressing climate change issues, [3]. One of the main factors triggering climate change is the digital economy, especially due to the high energy consumption that occurs in data centers and digital infrastructure. Data centers have a very important role in storing and processing large amounts of data generated in the digital era, so these data centers consume large amounts of energy. According to a recent report from the International Energy Agency (IEA), data centers and network infrastructure consumed approximately 1% of the world's total electricity production in 2019, and it is predicted that this number will continue to increase with the wider expansion of digitalization, [4].

The rapid growth in the digital economy has encouraged the development of Green Information Technology (Green IT) as a necessary response to reduce its negative impact on the environment. Green IT, as explained in [5], focuses on the use and research of information technology to improve environmental sustainability. The main concern is IT operational energy consumption, which has a significant impact on global carbon emissions, [6]. Apart from that, the problem of electronic waste arising from technological advances also shows the importance of Green IT, [7].

The connection between IT and climate change is not only in energy consumption but also involves the lifecycle stages of IT, from manufacturing to disposal. The IT industry is estimated to contribute 2% of global CO2 emissions, equivalent to the aviation industry, [6]. Amid digital economic

growth, synchronization with green economic growth becomes crucial to preventing a climate crisis and involving comprehensive actions, [7]. The importance of Green IT brings changes in how we understand, implement, and measure the environmental impact of IT use. Green IT includes aspects such as energy efficiency, electronic waste management, and the contribution of IT in solving environmental issues.

Previous studies focused on the organizational level, accommodating models such as the Technology Acceptance Model (TAM) and the Belief-Action-Outcome (BAO) framework. Nevertheless, there is a research gap at the individual level, particularly in the relationship between the behavior of IT users and the environmental performance of organizations. In this study, we aim to bridge a gap by merging two theoretical models (TAM and BAO), to explore how IT users perceive and approach the implementation of Green IT practices for environmental sustainability. This research holds significant importance in the effort to enhance Environmental IT Performance by gaining a profound understanding of how Perceived Ease of Use and Perceived Usefulness are associated with GIT Attitudes and Engagement in Green IT Practice. This research has the potential to provide valuable guidance for organizations in developing policies and strategies that support green economic growth.

Furthermore, the study may contribute to reducing carbon footprints and greenhouse gas emissions by motivating the adoption of more sustainable IT practices. By integrating psychological and practical aspects, this research is expected to stimulate positive changes towards more responsible IT use, impacting the environment positively, and understanding the dynamics between individuals, organizations, and the sustainability context.

2 Literature Review

2.1 Belief – Action – Outcome (BAO) Framework

BAO framework is introduced by Nigel P. Melville. The underlying issue addressed by this theory revolves around information systems and environmental sustainability, encompassing human behavior within social, organizational, and environmental contexts.

According to [8], these three phenomena collectively comprise micro and macro problems. [9] micro-macro relationship model serves as the foundation for the conceptual framework known as Belief-Action-Outcome (BAO). Emphasizing the mediating role of individuals, this model establishes a link between macro-level variables, such as social structure, and the behavior of social systems. The three types of relationships outlined include (1) macro-level variables, like social structure, influencing the psychic states (beliefs, desires, opportunities, etc.) of individuals; (2) psychological states influencing individual actions; and (3) the cumulative actions of individuals impacting macro-level variables, such as the behavior of social systems.

In the elucidation of this theory, belief is delineated as how psychic states (beliefs, desires, opportunities, etc.) regarding the natural environment are shaped through the lens of macro-micro analysis, [8]. Meanwhile, action in the BAO framework, serves as the manifestation of psychic expression regarding the natural environment translated into tangible actions, [8]. The analytical level encompasses micro-micro, with the primary constructs being the actions undertaken by individuals. Examples include the adoption of an information system to enhance organizational recycling or facilitate ride-sharing, [8]. The terminologies of various theories, such as game theory, social cognitive theory, technology acceptance model, theory of planned behavior, and theory of reasoned action, contribute to the underpinning of this aspect.

Within the BAO framework, the terminology associated with outcomes delineates how sustainability actions influence social systems and organizations and how macro-level states impact individual and organizational behavior, [8]. The constructs involve community behavior, reflecting the interplay between society and the natural environment (inclusive of performance), and organizational behavior, encapsulating the operational dynamics of the organization (inclusive of performance).

2.2 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a theoretical framework employed to elucidate an individual's acceptance of technology use, particularly information technology systems, [10]. According to [10], TAM is derived from the Theory of Reasoned Action (TRA), an action-oriented theory positing that an individual's reactions and perceptions shape their attitudes and behavior. [11], asserts that TAM predicts user acceptance of information technology systems based on two

variables: perceived usefulness and perceived ease of use.

Throughout its development, TAM underwent several modifications, including the addition of behavioral intention variables directly influenced by perceived usefulness, [12]. [12], propose instances where users might form an intention to use a system considered easy without initially exhibiting an attitude. The model is depicted as follows. The testing results of the above model reveal a direct impact of perceived usefulness and perceived ease of use on the intention to use. The model was subsequently refined into the ultimate TAM model. In the final model suggested by [13], the influence of attitude toward use variables could be eliminated and consists of five main components: external variables, perceived usefulness, intention to use, perceived ease of use, and actual use.

As explained in [12], Perceived Ease of Use includes the belief that using a particular system will require minimal effort. On the other hand, Perceived Usefulness is defined as the belief that the use of a particular system will improve job performance, [14], [15].

2.3 Research Conceptual Model and Hypothesis Development

This research focuses on the significant role of information technology (IT) in today's society and its impact on the environment, [16]. This research integrates two main theories, namely the Belief-Action-Outcome (BAO) and Technology Acceptance Model (TAM). Based on TAM, [17], developed a model for adopting Green IT that included Green IT awareness and subjective norms as external variables. The importance of TAM in examining environmental behavior facilitators is highlighted by their study. TAM also served as the fundamental theoretical model that, [18], used to forecast and elaborate on individual acceptance of Green IT. The use of TAM to forecast user acceptance of IT systems is dependent on two factors, namely perceived utility and perceived ease of use, as confirmed by Davis.

Hypotheses in research are needed as tentative assumptions about the research questions or, in other words, hypotheses are predictions about the expected research outcomes. In line with the GIT context, the author argues that the applied TAM model in this study, namely, perceived ease of use, directly influences the intention to use IT. Based on these considerations, the conceptual model of this study is outlined in Figure 1.

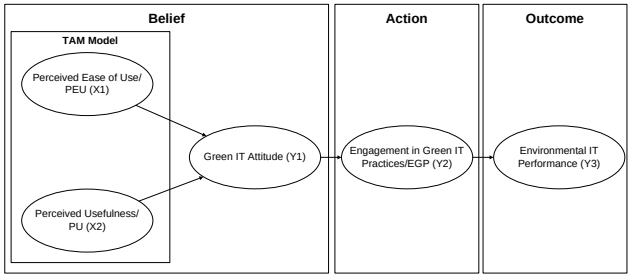

Fig. 1: Research Conceptual Model
Source: Processed by Author (2023)

Therefore, the following hypotheses are proposed:

H1: Perceived Ease-of-Use significantly influences GIT Attitude

H2: Perceived Usefulness significantly influences GIT Attitude

H3: GIT Attitude Significantly Influences Engagement in GIT Practice

H4: Engagement in GIT Practice Significantly Influences Environmental IT Performance

H5: Engagement in GIT Practice mediates the relationship between GIT Attitude and Environmental IT Performance

3 Methodology

The location of this research is IT users who are in a logistics company in East Java in 2023. This research was carried out individually using an online Google form which was distributed to the permanent employees and contract companies of the company. The population in this study are all employees who work in a logistics company in East Java.

To assist in addressing the established research questions, this research will utilize a survey method, with a questionnaire distributed to IT users in companies. The questionnaire results will undergo processing and analysis using PLS-SEM data analysis. The researcher anticipates that the outcomes of this data analysis will effectively address the research questions, achieve the research objectives, and provide academic and governmental insights for promoting wiser usage of information technology within society.

The sample is a part of the population to be investigated and its information is collected to explain a phenomenon in research, [19]. To achieve the objectives of this study, the author uses a sample that is a small part of the population. The research sampling method used is proportionate stratified sampling. Proportionate stratified sampling involves stratifying the population into homogeneous groups (Strata).

As a general guideline, [20], the minimum sample size should be at least five times the number of questionnaire items to be analyzed, and a more acceptable sample size maintains a ratio of 10:1. With 23 questionnaire items used in this study, the required minimum sample size is 23 x 10 = 230 samples. The population and sample allocation in this research are shown in Table 1.

Table 1. Outer Loading for Each Variable

Department	Population	Sample
Logistics Facilities Division	194	112
Project and Development Division	152	87
Finance and Procurement Division	31	18
HR, General, and K3 Divisions	23	13
Total	**400**	**230**

Source: Processed by Author (2023)

The data collection method employed in this research comprises both primary and secondary approaches. Primary data collection involves an online survey, where primary data refers to information obtained directly by the researcher related to the variables of interest for specific purposes, [20]. This primary data can be processed and analyzed directly in this study. The primary data for this research comprises respondents who are IT users working in logistics companies in East Java by online survey. The online survey utilized Google Forms and was distributed to the respondents. Secondary data collection involves gathering various supporting research information from literature or reading materials, such as books, articles, journals, official websites, or other sources that can be authenticated. This study utilizes two exogenous variables: perceived ease of use (X1) and perceived usefulness (X2). The endogenous variables in this study are GIT attitude (Y1), engagement in GIT practices (Y2), and environmental IT performance (Y3).

4 Results and Discussion

4.1 The Results of the Validity and Reliability Test

The convergent validity of the measurement model was carried out with reflexive indicators assessed based on the correlation between the component scores and latent variable scores or construct scores. The convergent validity results are shown in Table 2.

Table 2. Convergent Validity Test Results

Variable	Items	Loading Factor	Information
Perceived Ease of Use	X1.1	0.862	Valid
	X1.2	0.883	Valid
	X1.3	0.914	Valid
	X1.4	0.882	Valid
Perceived Usefulness	X2.1	0.729	Valid
	X2.2	0.836	Valid
	X2.3	0.766	Valid
	X2.4	0.750	Valid
	X2.5	0.764	Valid
GIT Attitudes	Y1.1	0.763	Valid
	Y1.2	0.722	Valid
	Y1.3	0.700	Valid
	Y1.4	0.760	Valid
Engagement in GIT Practice	Y2.1	0.785	Valid
	Y2.2	0.910	Valid
	Y2.3	0.757	Valid
	Y2.4	0.904	Valid
Environmental IT Performance	Y3.1	0.700	Valid
	Y3.2	0.700	Valid
	Y3.3	0.785	Valid
	Y3.4	0.864	Valid
	Y3.5	0.792	Valid
	Y3.6	0.768	Valid

Source: Processed by Author (2023)

Based on Table 2, the loading factor value of each item associated with a variable or construct with a value of 0.5, the measurement instrument can be said to be valid, [21]. Table 2 shows that all loading factor values are greater than 0.5. Based on this, it can be concluded that all the indicators used for each variable have the function of measuring properly and precisely with the measuring instruments that have been used in the study

Next, the discriminant validity can be seen from the Average Variant Extracted (AVE) value. Fulfillment for testing discriminant validity, which is equal to 0.5. AVE test results in Table 3 are as follows.

Table 3. Average Variant Extracted (AVE)

Variable	AVE	Information
Perceived Ease of Use	0.784	Valid
Perceived Usefulness	0.593	Valid
GIT Attitudes	0.542	Valid
Engagement in GIT Practice	0.709	Valid
Environmental IT Performance	0.593	Valid

Source: Processed by Author (2023)

Based on Table 3, it can be seen that the value of the Average Variance Extracted (AVE) has been able to explain that all research variables have an

AVE value of more than 0.5. The existence of this has shown that the instruments used in research are valid. The AVE value can also be used to measure the variables in the study

Composite reliability is a way to test the level of reliability of variables provided that the Cronbach alpha value is more than 0.6 and the composite reliability value is more than 0.7. In addition to the Cronbach's Alpha value, the rho_A value is also seen. A construct is said to be reliable (indicator) if the value of rho_A > 0.7, [22]. The composite reliability results are shown in Table 4.

Table 4. Composite Reliability Test Results

Variable	Cronbach's Alpha	rho_A	Composite Reliability
GIT Attitudes	0.719	0.721	0.826
Perceived Ease of Use	0.908	0.912	0.936
Perceived Usefulness	0.828	0.832	0.879
GIT Attitudes	0.719	0.721	0.826
Engagement in GIT Practice	0.860	0.862	0.906
Environmental IT Performance	0.862	0.874	0.897

Source: Processed by Author (2023)

The value of Cronbach Alpha and the composite reliability value of all variables have a cut-off value over 0.6, as Table 4 above demonstrates. Additionally, Table 4 demonstrates that the total value of rho_A is higher than 0.7. Concurrently, the composite reliability's overall value is more than 0.7. This leads one to the conclusion that every research variable was trustworthy. These findings demonstrate that every instrument utilized in the study was error-free and appropriate for additional investigation.

4.2 Hypothesis Testing Results (Inner Model)

To ascertain the direct and indirect effects of each hypothesis put forward in this study, hypothesis testing was done. Testing the structural model in route analysis is the same as analyzing the link between latent/construct variables in the SEM model. The analysis in this paper made use of SmartPLS software and bootstrapping. Hypothesis testing gives the following results (Table 5).

Table 5. Hypothesis Testing Results (Inner Model)

Hypothesis	Path Coefficient	P-values	Information
H1: Perceived Ease of Use (PEU) (X1) → GIT Attitude (Y1)	0.136	0.058	Not significant
H2: Perceived Usefulness (PU) (X2) → GIT Attitudes(Y1)	0.471	0.000	Significant
H3: GIT Attitudes (Y1) → Engagement in GIT Practice (EGP) (Y2)	0.468	0.000	Significant
H4: Engagement in GIT Practice (EGP) (Y2) → Environmental IT Performance (Y3)	0.562	0.000	Significant
H5: GIT Attitudes (Y1) → Engagement in GIT Practice (EGP) (Y2) → Environmental IT Performance (Y3)	0.263	0.000	Significant

Source: Processed by Author (2023)

The test results in Table 5 will be explained in detail in the following discussion.

4.3 Discussion

4.3.1 The Effect of Perceived Ease-of-Use on GIT Attitude

The effect of Perceived Ease-of-Use on GIT Attitude (Attitude towards General Information Technology) is a crucial aspect frequently examined in the context of technology adoption. Perceived Ease-of-Use pertains to an individual's perception of how easily and effortlessly a system or technology can be utilized. GIT Attitude delineates an individual's stance toward information technology in general, encompassing a positive or negative inclination toward technology use.

The inner model test results revealed that the absence of a significant influence relationship

between the Perceived Ease Of Use variable and GIT Attitude led to the substantiation of the hypothesis. The theoretical foundation for this hypothesis rests upon the Technology Acceptance Model (TAM) and Belief-Action-Outcome (BAO) theories. According to these theories, issues involving information and environmental sustainability entwine human behavior and the social, organizational, and environmental contexts.

Theoretically, IT users might provide further context for respondents' comments by clarifying how the Perceived Ease of Use variable affects GIT Attitude. The Perceived Ease Of Use variable gauges the extent to which an individual believes that using a specific system will be effortless. Additionally, Green Information Technology is defined as information technology with minimal direct effects on the environment.

The non-significant research findings contradict [23] but align with the [24] study. [24], suggest that the non-significant impact of perceived usefulness on user attitudes may be attributed to users' familiarity with a long-established information technology system within a company. This observation is linked to user age, work tenure, education level, and the duration of system usage.

Conversely, the non-significant findings in this study indicate the presence of other potentially more dominant factors shaping attitudes toward technology, such as Perceived Usefulness (perception of benefits derived from technology), users' prior experiences, social factors, or other personal characteristics. It's possible that while creating their general opinions regarding information technology, people will value these qualities more than simple usability. IT users may have a broader understanding of technology and base their opinions on it on factors including scalability, security, dependability, and interoperability with current systems.

4.3.2 The Effect of Perceived Usefulness on GIT Attitude

The results of this investigation agree, for the most part, with the theories (Belief-Action-Outcome (BAO) and Technology Acceptance Model (TAM)) that guided the creation of the hypotheses. The diffusion theory of the Technology Acceptance Model (TAM) also acknowledges that the impression of ease of use impacts technology acceptance. This indicates that in a technological setting, the intention to continue using technology is influenced by the Perceived Usefulness component.

The findings of the final model fit test demonstrated a significant influencing association between the GIT Attitude and the Perceived Usefulness variable. Based on these results, the desire to continue using the technology is driven by its benefits as long as the benefits are clear. Research to date suggests that GIT attitudes are significantly influenced by perceived benefits. People are more likely to have positive attitudes toward information technology in general if they believe that using the system or technology will improve their productivity or quality of life. A person's attitude toward technology can be positively influenced by their belief that technology helps them achieve their goals and provide better work results.

Concerning green technology use, the extent to which perceived effectiveness influences GITs' attitudes toward continued use of information technology is consistent with research findings, [25], [26]. Respondents' perceptions of positive or negative attitudes toward environmental change and their attitudes toward the use of information technology, as well as their work as IT users in companies that prioritize technology development, may have contributed to the observed significant impact.

4.3.3 The Effect of GIT Attitude on Engagement in GIT Practice

The study's findings indicate a strong relationship between engagement in GIT practice and GIT Attitude. This result suggests that different elements of commitment in the implementation of technology usage are aligned with the components of technology adoption, comprehension, learning, utilization, and appeal. Environmental performance may be influenced by actions made to maintain a business.

The Belief-Action-Outcome (BAO) Theory, as explained by [27], holds that a company's sustainability activities may affect environmental performance across GIS strategy, GIT practices, and GIS practices. The research findings are conceptually consistent with this theory. The goal of the GIS approach is to limit environmental deterioration through organizational and functional-level interventions. The results of this study close the gap in empirical testing on the relationship between GIT Attitude and Engagement in GIT Practice.

Energy efficiency, lowering carbon emissions, recycling hardware, managing electronic waste, using resources sustainably, and utilizing technology that promotes sustainable behaviors all fall under the category of "green IT attitudes". These quotes demonstrate social responsibility as well as

knowledge of the environmental effects of technology use. When making information technology decisions, people or companies with good Green IT attitudes typically consider the environment. They could actively look for green tech developments and solutions, use energy-saving gear and software, or embrace sustainable maintenance and use procedures.

Positive attitudes toward information technology are associated with higher levels of motivation for people to use technology in their daily lives. They view technology as a useful and efficient instrument for achieving their goals. The accomplishment of these objectives promotes acceptance and use of different pertinent features, applications, or technology systems, as well as active participation in technology use practices. Positivity also makes people more curious and open to learning about new developments in the field of information technology. People who have a favorable outlook on information technology are more likely to adopt best practices in technology use, learn new functionalities, and keep up with the newest advancements.

4.3.4 The Effect of Engagement in GIT Practice on Environmental IT Performance

To meet corporate or personal goals, one must understand, embrace, and actively use information technology (GIT Practice). Environmental IT Performance can benefit from more Engagement in GIT Practice. People who engage in these activities usually use information technology as a tool to help them achieve their goals, improve productivity, increase efficiency, and improve their quality of life in general. An important relationship between the impact of the Engagement in GIT Practice variable and Environmental Performance has been confirmed by the analysis of the final model that was provided in this study. This impact's theoretical foundation supports the Belief-Action-Outcome (BAO) hypothesis. These results can be utilized to clarify that technology advances environmental performance when it is understood and applied with strong dedication. This study also validates previous research conducted by [28] and [29].

4.3.5 Engagement in GIT Practice mediates the relationship between GIT Attitude and Environmental IT Performance

Engagement in GIT Practice includes sustainable use of information technology, that requires implementing additional environmental action, such as participating in e-waste management programs, energy-saving technologies, etc. The findings from this study indicate that Engagement in GIT Practice can act as a mediator between GIT attitudes and environmental IT performance. These findings are consistent with previous research conducted by [30].

4.4 Recommendations

We would like to highlight several recommendations from this study that should be considered to fully understand the study's findings. These limitations are:

1) Inserting technology that supports the environment is very important and must be the main focus, both for individuals and businesses. By promoting and emphasizing the benefits of sustainable use of information technology, we can inspire a more positive view of environmentally friendly information technology.
2) Organizations need to take proactive action to encourage and support the use of environmentally friendly information technology practices. This can be achieved through providing guidance, providing resources, as well as encouraging sustainable actions such as the use of energy-efficient software, responsible management of e-waste, and participating in carbon emission reduction efforts.

5 Conclusion

From the results of the research and analysis produced, several findings can be concluded. First, it was found that perceived ease of use does not have a significant influence on GIT attitude. This indicates that people's views on information technology in general tend to be less influenced by the extent to which they believe that the technology is easy to use. On the other hand, GIT attitudes are strongly influenced by perceived usefulness.

Furthermore, it is noteworthy that GIT Attitude has a substantial influence on Engagement in GIT Practice, signifying that a constructive outlook toward technology encourages proactive involvement in Green Information Technology activities. Additionally, the study shows that Environmental IT Performance is highly influenced by GIT Practice Engagement, suggesting that active participation in sustainable IT practices has a favorable impact on environmental results. Furthermore, participation in GIT Practice acts as a mediator and has a major impact on the connection between Environmental IT Performance and GIT Attitude.

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