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Assessing the role of information technology in promoting environmental sustainability and preventing crime in E-commerce

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ABSTRACT

The rise of e-commerce necessitates sustainable practices for a greener future. While the e-commerce boom offers immense economic opportunities, minimizing its environmental impact and upholding ethical business conduct are essential. Current research on e-commerce heavily focuses on information technology (IT) for understanding and improving consumer acceptance. However, a critical gap exists in exploring IT's potential contributions to sustainability, crime prevention, and environmental safety. This study bridges this gap by exploring the role of IT integration in managerial practices to enhance environmental protection, crime prevention, and foster sustainability within Bangladesh's booming e-commerce sector. Focusing on e-commerce managers' perspectives, the research examines effective leadership strategies for IT implementation. Additionally, it utilizes the Technology Acceptance Model (TAM) to analyze the relationships between user perception and its impact on e-commerce performance. Using a structured questionnaire, we collected the data from 418 e-commerce managers. The research design incorporates a robust framework, hypothesis formulation, and methodological rigor grounded in TAM principles. The findings reveal a significant positive contribution of IT to environmental protection, crime prevention, and overall sustainability within the e-commerce sector. Managers' perceptions highlight that effective IT utilization ensures environmental safety, safeguards data against criminal activity, and promotes organizational sustainability. Furthermore, this research provides a roadmap for e-commerce businesses to accelerate their sustainability efforts. It also equips academics with valuable insights to advance knowledge on building a secure and sustainable future in the digital age.

KEYWORDS

information technology, sustainable e-commerce, crime prevention, environmental impact, technology acceptance model

1. INTRODUCTION

The integration of information technology (IT) into various sectors has dramatically reshaped our daily lives and business practices, presenting remarkable opportunities for growth and efficiency. In the realm of e-commerce, IT not only enhances operational capabilities but also plays a pivotal role in addressing critical issues such as environmental sustainability and crime prevention [1]. Information technology (IT) encompasses more than just software platforms and databases. It includes comprehensive systems that businesses use to manage all critical operations. These systems go beyond the capabilities of traditional,

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generic database solutions by offering a wider range of functionalities and deeper integration across various aspects of the organization [2, 3]. However, contemporary academic and mainstream literature has analyzed the impact of information technology (IT) on facilitating cooperation and the exchange of information inside and across different organizations [4].

Furthermore, businesses play a crucial role in delivering the goods and services that fulfill our needs and generate employment opportunities. However, their activities frequently impose significant environmental costs. These costs are represented as pollution from waste products, depletion of natural resources, and high levels of energy consumption [5]. However, without proper management, these environmental impacts can result in severe public health issues and disrupt ecosystems [6]. Moreover, the increasing issue of non-recyclable waste and the illegal disposal of hazardous materials poses significant financial challenges due to their accumulation in landfills. These actions, often stemming from a lack of awareness about proper disposal methods, can be considered environmental crimes. This study seeks to identify effective strategies to safeguard our environment from these detrimental practices. It is necessary to adopt a comprehensive approach and include all stakeholders to avoid these environmental offences effectively. Researchers hypothesize that increased utilization of information technology can facilitate the prevention of adverse environmental activities in e-commerce businesses. Accordingly, researchers will examine the effectiveness of information technology (IT) in promoting environmental stewardship by analyzing the perspectives of managers who utilize IT for these purposes.

Adebayo et al. [7] identified that IT has the potential to significantly influence sustainable practices, enabling improved management and mitigation of environmentally harmful activities. According to Zhu et al. [8], the integration of IT in production and consumption processes has resulted in decreased wastage and energy conservation due to automation and reduced reliance on human resources. The writers also stated that increased utilization of information technology resulted in outsourcing, remote work, and less use of official resources. Furthermore, carbon emissions are rising due to the use of electricity and gas in factories, offices, and workplaces, which power various appliances such as lights, fans, air coolers, air conditioners, and heaters. Furthermore, the management of electronic waste generates considerable difficulties regarding sustainability and operational efficiency [9], which has led to the exploration of innovative approaches for product re-manufacturing or the development of more energy-efficient manufacturing systems. Integrating information technology in the pursuit of sustainability has led to a movement that advocates for environmentally responsible practices in e-commerce enterprises. If the IT system actively engages in environmental concerns and preventative actions, it governs corporate processes in a manner that maximizes energy efficiency and effectively manages electronic waste [9]. The integration of an environmentally friendly IT

system is a crucial element in sustainable operations management. It encompasses various essential operational activities, including responsible disposal and recycling, power management, data center management, server virtualization, regulatory compliance, metrics, assessment tools and methodologies, environmental risk mitigation, and the utilization of renewable energy sources [8, 10, 11].

However, the present research indicates three key factors; “environmental safety”, “prevention from environmental crime”, “sustainability”, which all factors are practically broad factors. Moreover, prior studies use these factors both unidimensional and multidimensional perspectives, for example, Meško et al. [12], Sharif et al. [13], Paukku [14], and Margiotta-Casaluci et al. [15]. This research followed the unidimensional perspective of the variables following Meško et al. [12] and Glinskiy et al. [16]. Moreover, Polites et al. [17] suggest that unidimensional (one-directional) measurement of variables can be a helpful tool for researchers seeking to refine broad research topics.

Additionally, this study applies the technology adoption model (TAM), because it explains how technical skills, efficiencies, expertise in utilization, and managerial decisions of businesses influence their adoption of technology. Besides, it provides a theoretical knowledge and conceptualization for comprehending the administrative activities of managers in IT-related online businesses [18]. The concept of TAM is broadly applied and discussed by prior scholars in their research. For instance, Musa et al. [19] presented a comprehensive study of TAM application and difficulties in the e-commerce sector. In the context of e-commerce applications, Nabelsi et al. [20] proposed integrating the Task-Technology Fit Model with the Technology Acceptance Model (TAM) to gain a more comprehensive understanding of user behavior. Likewise, Saif et al. [21] claim that the Technology Acceptance Model (TAM) needs to be expanded to encompass the challenges and opportunities presented by AI and emerging technologies. This would allow IT managers to leverage TAM for understanding user adoption and developing innovative strategies in this evolving landscape.

E-commerce’s latest advancement lies in the synergy of creative ideas and technical expertise. This strengthens fraud prevention through robust payment processing, cryptography, advanced analytics, and a focus on natural security. By combining these elements, businesses can safeguard customer information and proactively identify potential vulnerabilities [22]. By increasing administrative issue resolution productivity and accelerating the appropriation of innovation tailored to the specific goals of the directors, the appropriate utilization of IT with environmental concerns can improve an organization’s critical approach from environmental crime prevention. Managers need to incorporate e-commerce technologies within the digital business arena for their development and prosperity.

Information technological support is a pivotal factor in evaluating managerial decision making while conducting online business management such as, bolstering security measures, averting criminal activities, and upholding sustainable practices. By anticipating these circumstances,



enterprises can better prepare for and adjust to how stakeholders will receive their managerial IT technologies. While current research on e-commerce emphasizes the role of information technology (IT) in understanding and improving consumer acceptance [23, 4, 13, 19, 21, 24], a critical research gap exists in exploring its potential contributions to sustainability, crime prevention, and environmental safety. This suggests a need for further exploration of these broader aspects.

This research aims to bridge this gap by investigating how IT can be leveraged to achieve both environmental and crime prevention goals within the framework of sustainable e-commerce. Through rigorous research and analysis, this work aims to provide novel insights and deepen our understanding of these crucial aspects.

According to the aims of this research, we intend to investigate the following empirical questions:

- RQ1: Does Information Technology usage have effects on environmental safety?
- RQ2: What are the roles of Information Technology usage in preventing environmental crime?
- RQ3: What are the impacts of Information Technology usage on Promoting Sustainability?

The present research proposes the following conceptual framework presented in Fig. 1.

Building on the theoretical foundation discussed earlier, the first step is to assess the validity of the technology acceptance model (TAM) in explaining the proposed correlation. Subsequently, we assessed the relevant literature that was discussed in the second half of this research. The purpose of this research argument is to establish a comprehensive understanding of all the research variables, enabling us to derive significant conclusions regarding their interrelationships. Thus, we formulate the hypotheses to examine the interactions among all constructs. The methodology is employed to evaluate the assumed hypotheses. This section explores the study's findings, analysis, significance, constraints, and potential avenues for further investigation.

2. LITERATURE REVIEW

2.1. Technology acceptance model (TAM)

The TAM model is a crucial tool for evaluating user acceptance of new technologies such as IT usage of e-commerce sectors, focusing on perceived benefits, ease of use, effectiveness, and efficient usage by the managers, particularly in promoting environmental stewardship and technological safety [25]. Businesses must promote the use of technology that enhances safety, prevents crime, and promotes sustainability by integrating it into their information systems and e-commerce strategies [26]. The TAM model focuses on security, stability, and crime prevention through trust, and operational leadership management and supports new technologies in e-commerce and IT [23]. In addition to that, Isrososiawan et al. [23] refers to fine-tuning the existing technology adoption model and incorporating safety measures, sustainability and to curb crime, maintaining security in electronic commerce, and deploying IT solutions.

An extensive analysis using different models and frameworks is crucial for the successful execution and integration of technology in the fields of e-commerce and IT. The theory that includes perceptions of usefulness, user-friendly, social influence, and facilitating conditions has the potential to reveal users' attitude towards technology and their openness to adopting electronic marketing strategies in the tourism industry [27]. The Technology Acceptance Model (TAM) influences individual technology adoption by emphasizing the critical roles of perceived usefulness and ease of use. Additionally, organizational climate and technology adoption are fostered by focusing on infrastructure, culture, adaptability, and environmental responsiveness [28, 29]. To influence stakeholders' inclination to use the disadvantages of encryption, the TAM model measures how ready businesses and individuals are to adopt IT and e-commerce solutions. Businesses may experience some variables influencing IT projects, e-commerce strategy for sustainability, curbing crime, and protecting the environment by combining its model with the present structure [30].

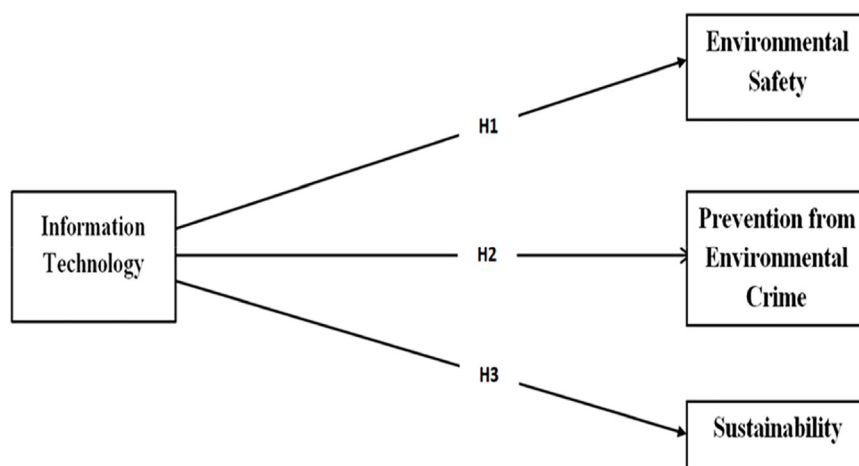


Fig. 1. Framework program of research. Note: developed by the authors

2.2. Leveraging IT for environmental safety

By assimilating Green Sustainability in Information and communication Technology system practice has significantly improvised by tranquilizing its effect on the environment [31]. Through the efficient use of resources like energy and materials, Information Technology (IT) plays a vital role in promoting sustainability, with the technological advancement of Information Technology organization can communicate remotely which results in saving travel expense less energy usage, less carbon emission and cut down on wastage by increasing output [32]. Information technology helps organizations to identify and improve its sustainability areas, facilitating data collection analysis, with recognizing the growing importance of information system research in the renewable energy sector [28, 33]. With the development of information technology rise of AIG, SIG and related conference and journals relating to environmental sustainability issues are being increasingly discussed and able to spread awareness [32, 34].

On the contrary, the developments in IT have significantly enhanced sustainability. The use of sustainable information and communication technology (ICT) systems and practices, as well as the adoption of such technologies, has had a major impact on sustainability [35]. Notably, these technical advancements have enabled organizations to make more informed decisions regarding resource management and waste reduction while also reducing the energy consumption of IT equipment. Ensuring sustainability is also heavily influenced by managerial practices, the quality of technology, and the culture of information [36]. Coordination between IT and other company resources is necessary for IT to provide a sustainable contribution [37]. Therefore, the following theories are put forth:

H1: Environmental safety and information technology are positively correlated.

2.3. IT-based environmental crime prevention

The significance of crime prevention from environmental threats and mitigating criminal activities to ensure public safety is universally acknowledged. A thorough initiative to crime prevention, for example, Crime prevention through environmental design (CPTED) considers the impact of multiple, interrelated environmental elements on criminal activities to harm the society and business arena. The suggestions of Glasson & Cozens [38] have contributed to the evolution of approaches like CPTED by drawing attention to unique environmental projects and concepts. CPTED categories of research consistently explore territoriality, physical disorder, activity support, and target hardening, despite methodological variations [39, 40]. However, the advancements in information technology, environmental design, crime prevention, and sustainable development have significantly improved in recent years [41]. Advancements in information technology improve data processing accuracy, enabling deeper analysis of crime trends, improved surveillance, and real-time sensor monitoring, enhancing community safety and law enforcement intervention [42].

Moreover, IT enhances access control systems, manages access points effectively, reduces energy consumption, and supports sustainability through smart lighting and sensor-based surveillance. Information technology advancements improve access control systems, smart lighting, and monitoring, reducing energy usage and promoting sustainability through eco-friendly design and crime deterrence measures. Besides, information technology significantly aids in combating environmental crimes through improved data gathering and analytical capabilities, leading to more effective tactics and informed decision-making, resulting in secure and sustainable environments [43]. Digital technologies facilitate knowledge sharing and collaboration in environmental sustainability, crime prevention, urban planning, and architecture, promoting best practices and best practices among professionals [44]. This study explores the importance of information technology in enhancing sustainability through environmental design and crime prevention, based on existing research and hypothesis:

H2: Information Technological is positively related to the Prevention from Environmental Crime.

2.4. Promoting sustainability through the usage of IT

The utilization of technology is critical for the promotion of sustainability as it enables organizations to adopt ecologically conscious procedures and reduce their carbon footprint. Technological progress increasingly impacts sustainability. The utilization of information technology is crucial in promoting environmentally friendly practices and reducing the environmental impact of businesses. Adopting green information and communication technology practices, along with utilizing sustainable information technologies and systems, is crucial in the modern era [35]. Companies can adopt green computing practices to ensure that computer systems and IT infrastructure are designed, manufactured, and used in an environmentally responsible manner [45]. This not only mitigates the adverse environmental consequences but also yields economic and social advantages.

Several effects of information technology on advancing sustainability include: Information technology enables the creation of energy-efficient systems and devices, such as servers, storage devices, and data centers, which consume less energy. Through the optimization of power management and the implementation of energy-saving measures, IT operations can attain enhanced energy efficiency, leading to decreased energy consumption and cost savings. Preservation of Resources refers to the virtualization, cloud computing, and consolidation of data centers, which are a few examples of how IT may improve resource utilization. These procedures enable the most efficient utilization of computing resources, consequently reducing the need for physical infrastructure, and minimizing resource consumption. Information technology facilitates the sustainable tracking and supervision of supply chains within organizations, fostering a culture of transparency and accountability.



Sustainable IT strategies can enhance energy conservation in corporate settings, providing economic benefits, reducing environmental impact, and promoting fair employment standards and ethical resource acquisition [46]. Information technology streamlines resource management, tracking energy consumption, and reducing dependency on tangible infrastructure, promoting sustainable operational methods, energy conservation, and eco-friendly behaviors. Moreover, information technology plays a crucial role in promoting sustainable practices, reducing energy usage and carbon emissions, and promoting environmental conservation, while balancing resource investments. The integration of environmentally friendly IT principles into management and financial systems can significantly enhance the sustainability of business operations [47]. This study examines the growing demand for sustainable IT practices in computer science, focusing on ecologically sound systems and sustainable practices, based on scholarly sources:

H3: The utilization of IT has been shown to significantly enhance sustainability efforts.

3. METHODOLOGY

3.1. Research design, measurement, and scaling

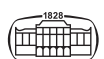
This study builds on the work of Cooper and Schindler [48] to investigate the possibility that all constructs might be interconnected. We analyze relevant primary data to see if this correlation exists and present our findings. The researchers have gathered cross-sectional data by using a developed systematic questionnaire [49]. However, the scales were adjusted from previous similar analyses. A questionnaire survey is a useful research approach for examining the potential bond between distinct variables and constructs, as it allows for the assessment of participants' perspectives [50]. In this experiment, various indicators were used to measure each latent variable. Respondents were instructed to indicate their perception of the level of agreement with each indicator using a five-point Likert scale, ranging from strong disagreement to strong agreement. The researchers identified several items on the questionnaire that were used to measure all latent components. We have adapted the scales of this study from prior similar research in other contexts. That is why we have modified the scales based on the context of this research. Thus, the levels were adapted from studies including information technology usage six items [51], environmental safety five items [52], prevention from environmental crime five items [53], and promoting sustainability five items [54]. [Appendix 1](#) exhibits all the extent reports according to the existing concepts.

3.2. Population and sampling method

This study focuses on managers in Bangladeshi e-commerce businesses. To ensure a targeted sample, the researchers employed judgmental sampling. This technique allowed

them to carefully select respondents who met specific inclusion criteria relevant to the research objectives. The inclusion criteria for selecting the respondents of this study were, firstly, managers who use information technology; secondly, managers who are educated and knowledgeable enough about information technology, environmental crime, data prevention, and related areas; thirdly, managers who are working in similar organizations for at least three years to provide more accurate and reliable information. Moreover, to provide easy access to data and maximize accuracy in the data collection technique, respondents were selected from organizations that agreed to provide their data. Comparably, ensuring data accuracy throughout country-wide data collecting in Bangladesh is challenging because of the country's enormous population and culture of entry restriction. In this study, judgmental sampling is used for two reasons. Firstly, collecting and maintaining a comprehensive population list proved to be a significant challenge [55]. Secondly, many companies often hesitate to share their employee rosters because of concerns about privacy [56]. Additionally, judgmental sampling not only offers cost-efficiency but also enhances the accessibility and effectiveness of utilizing data for informed decision-making [57]. However, accurate study results are achieved through the judgmental sampling strategy's focus on specific data attributes [58]. The researchers employed purposive sampling because this study objective was to predict and explore correlations between variables, rather than to generalize findings across the entire population.

In our survey, 418 e-commerce business managers participated. Based on the suggestions from Kline [59] and Wolf et al. [60] the researchers selected the sample size for this study. In this pertinent, Kline and Wolf recommended that when applying constructive equation modeling, each assembly should be measured with at least three components, and commonalities should be at least 0.5. Similarly, Boomsma [61] suggested that the bare minimum for a sample size of 200 or more is qualified to conduct SEM analysis. A total of five implicit variables were assessed using items in this study, with one variable using six questions (please see [Appendix-1](#)). Accordingly, the researchers of this study anticipate that the finalized sample size is enough for future studies. According to Nunnally et al. [49], the minimum sample size should be 10 samples for each variable. So, the present study may select at least 10 times of 4 variables in total 40 samples at the minimum [49]. This study developed and used questionnaire methods and initially we distributed 1,000 questionnaires to the target respondents. After excluding a few non-responses, missing questionnaire, improperly filled up, and invalid questionnaires finally, 418 valid filled up questionnaires were selected for further study. Ultimately, a total of 418 responses were finalized for this analysis. This surpasses the minimum sample size (384 samples) requirements suggested in previous studies by Kline [59, 62] and Faul et al. [63]. Furthermore, the response rate of 41.8% is acceptable, surpassing the 29% response rate observed in a prior study by Amin & Rubel [64] in the context of Bangladesh.



3.3. Pre-test with pilot study

This study uses a systematic survey form and conducts a questioning trial with 20 respondents, including 16 e-commerce business managers, 2 academicians, and 2 professional researchers, to ensure well-defined survey items [65]. Participants who filled out the survey were monitored closely and requested about any parts where they had trouble understanding the questions. Pilot studies were used to help write the questions, including how they were worded and arranged. A survey was administered in both English and Bangla language so that people who were feeling down could fill it out. Based on the recommendation of Teijlingen & Hundley [66], the authors carried out a pilot study to assess the suitability of the research methodology and the viability of the full-scale investigation. For the pilot test, 40 participants were randomly chosen [67], accounting for 10% of the entire sample. The pilot investigation demonstrated that the scales' internal stability was more than 0.7, indicating that the minimum requirement had been fulfilled [68].

3.4. Testing common methods of bias

Based on the recommendations of Podsakoff et al. [69], the survey instrument was refined to improve item clarity and response accuracy. Moreover, we reduced the dimension of the scale to prevent Common Method Biases (CMB) from influencing the results. The privacy of the participant's responses was further protected. Statistically, Harman's single-factor test was considered for the numerical detection of CMB in this research based on the recommendation of Maxwell & Harman [70]. If one component fails to account for the majority (50 percent or more) of the correlation among the factors and variables guaranteed by the threshold of Podsakoff et al. [69], therefore CMB will not constitute a major issue in the measurement process. According to this CMB test findings, one non-rotating latent component is responsible for 31.84% of the variation, which is less than 50% (please see Appendix 2). As a result, CMB may not cause any major problems in this investigation.

3.5. Data analysis tools and techniques

The analytical data for this research was initially organized and subsequently demographic characteristics were analyzed using IBM SPSS version 23. In addition, researchers employed PLS-SEM version 4 to evaluate the reliability and validity of the measurement model, as well as the relationships between variables in the structural model. Due to the small sample size and non-normal distribution of the data, PLS-SEM is a well-suited option for statistical analysis [71]. The primary emphasis is on how managers in e-commerce companies use IT. The researchers utilized PLS-SEM with SmartPLS due to its dual strengths: predictive power and the ability to analyze complex measures and structural models concurrently [72, 73].

4. ANALYSIS AND RESULT

4.1. Demographic profile information

To understand how managers perceive technology's influence, this study considers several demographic factors: age, educational background, gender, and work experience. The researchers posit that these factors, particularly a manager's educational background, work experience, technological proficiency, and ability to effectively utilize technology, are crucial for interpreting their perspective on technology use. The demographic data of this study represents a total of 418 respondents in Table 1, who are only individuals between the ages of 30 and more than 51. This study anticipates that the minimum age to become a manager should be at least thirty years. The largest number of responders seem to be between the ages of 41 and 50, according to the findings (239). Another noteworthy finding is that 61 out of a total of 118 respondents were in the 30–40 age bracket, suggesting that a larger number of Bangladeshi managers are active in overseeing e-commerce enterprises. The following Table 1 represents the demographic data of the respondents.

The managers of e-commerce organizations in Bangladesh holding that degree are either graduates or have advanced degrees, as seen in Table 1. A significant number of managers achieved a Diploma degree, i.e., 103, and a Postgraduate degree of 78. Besides, 387 managers stated they were married, while 31 remained single. There are a total of 184 managers who have been working in e-commerce companies for over 20 years, 218 with 10–19 years of employment experience, and 116 with 5–9 years of managerial experience.

4.2. Measurement model

The reliability and validity assessments of the measurement model related to the latent components for this study were conducted using confirmatory factor analysis, in short, CFA. Composite reliability (CR) and Cronbach's alpha scores were employed to determine reliability. All the numbers in Table 2 exceed the 0.7 criterion, meaning the research has appropriate reflective construct reliability. Study participants' item validity

Table 1. Demography of the respondents

Variables	Description	Frequency	Percentage
Age (in years)	30–40	118	28.23
	41–50	239	57.18
	51 & above	61	14.59
Education	Diploma	103	24.64
	Graduate	237	56.70
	Postgraduate	78	18.66
Gender	Male	216	51.6
	Female	202	48.33
Marital Status	Married	323	77.27
	Unmarried	95	22.73
Job Experience (in years)	5–9	116	27.75
	10–19	218	52.15
	20 & above	84	20.10



Table 2. Model of measurement (CFA outputs)

Constructs	Item Codes	Item Loadings	AVE	CR	Cronbach's Alpha
Environmental Safety (ENS)	ENS1	0.848	0.722	0.929	0.904
	ENS2	0.878			
	ENS3	0.888			
	ENS4	0.828			
	ENS5	0.805			
Information Technology (IT)	IT1	0.901	0.819	0.948	0.927
	IT2	0.923			
	IT4	0.915			
	IT6	0.881			
Promoting Sustainability (SUS)	SUS1	0.826	0.678	0.863	0.768
	SUS3	0.892			
	SUS5	0.745			
Prevention from Environmental Crime (PEC)	PEC1	0.863	0.657	0.884	0.829
	PEC2	0.791			
	PEC3	0.803			
	PEC4	0.781			

Note: The items such as, IT3 (0.517), IT5 (0.661), PEC5 (0.568), and SUS2 (0.444), SUS4 (0.272) needed to be separated for displaying poor loading score <0.70); Source: Generated using Smart-PLS 4.

was confirmed using factor loadings and AVE scores. According to Edeh [71], a construct is considered to have convergent validity if its factor loading value is above 0.7 and its AVE score is more than 0.6. In this investigation, all factor

loadings were above the suggested threshold of 0.6 and the acceptable level of 0.7, showing a good convergent validity. Both Edeh et al. [71] and Hair et al. [74] have advised that Hair has enough convergent validity, and this proves it. The following Table 2 shows the results from measurement model.

However, the following Fig. 2 shows measurement model before conducting confirmatory factor analysis.

Figure 2 depicts a complex structural equation model that illustrates the relationships between various constructs and their associated indicators. At the centre of this model is a construct labeled "IT", which serves as the focal point from which three paths emerge, leading to constructs named ENS, PES, and SUS.

Each construct is represented by a blue circle and is connected to several yellow rectangles, which denote their respective indicator variables. The IT construct is linked to six indicators (IT1 through IT6), while ENS has five (ENS1 to ENS5), PES has five (PES1 to PES5), and SUS has five (SUS1 to SUS5) indicators.

The model displays numerical values along the paths connecting the constructs, as well as between constructs and their indicators. These numbers represent the strength and direction of relationships within the model. For instance, the path from IT to SUS shows a value of 0.401, suggesting a moderate positive relationship.

Interestingly, the model includes small values within the circles representing ENS (0.077), PES (0.081), and SUS (0.161). These indicate the amount of variance explained in

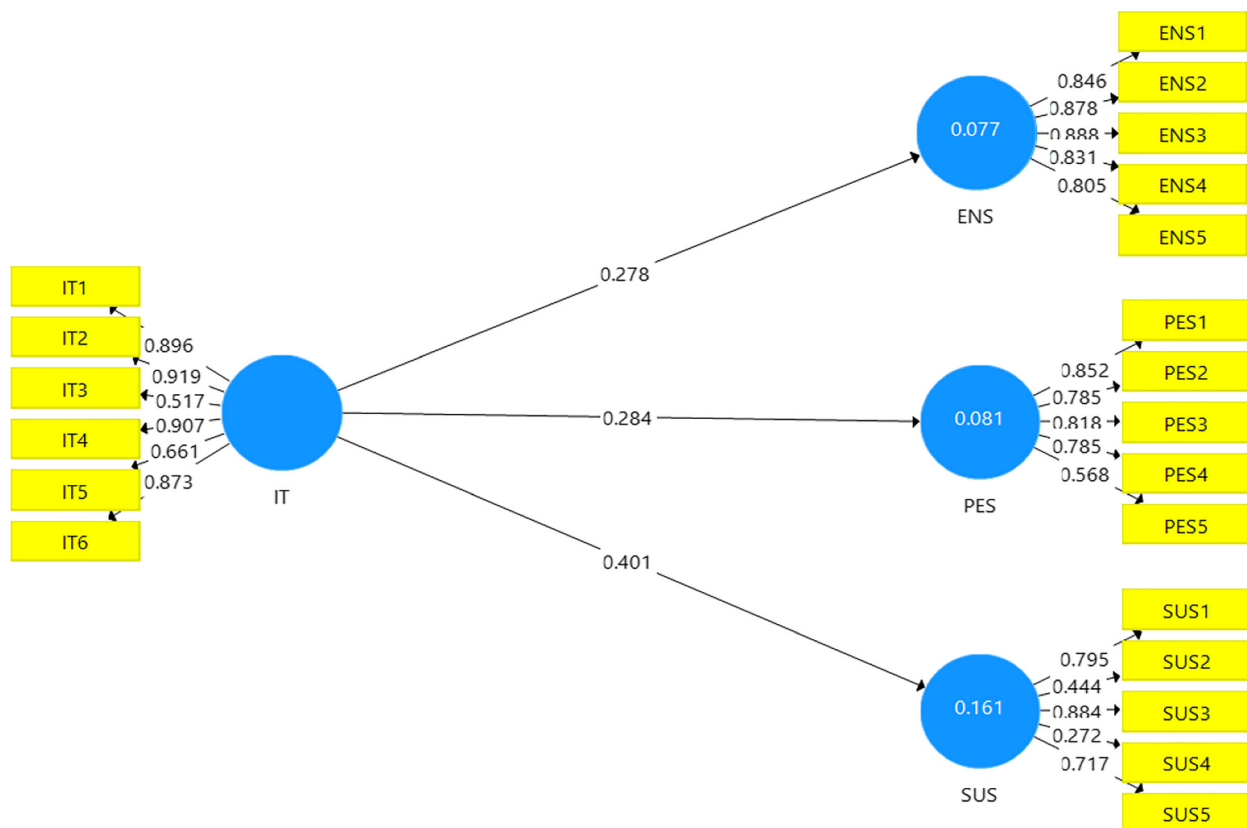


Fig. 2. Measurement Model before conducting Confirmatory Factor Analysis; Source: Smart-PLS 4

each construct by the IT factor. The connections between constructs and their indicators also show varying strengths. For example, the link between IT and IT2 has a value of 0.919, indicating a strong relationship, while the connection between IT and IT3 shows a lower value of 0.517, suggesting a weaker association.

However, this preliminary model provides a foundation for further analysis and understanding of the relationships between IT and the other constructs in the study.

Furthermore, the following Fig. 3 shows measurement model after conducting confirmatory factor analysis.

This structural equation model (Fig. 3) illustrates the refined relationships between constructs and their indicators following confirmatory factor analysis. The model reveals the strength of connections through numerical values. The path from IT to SUS shows the strongest relationship with a coefficient of 0.421, followed by PES at 0.300, and ENS at 0.289. These values suggest varying degrees of influence from IT on the other constructs.

However, the model displays small values within the circles representing ENS (0.083), PES (0.090), and SUS (0.177), indicating the amount of variance explained in each construct by IT.

The links between constructs and their indicators demonstrate high consistency. For IT, the indicators range from 0.881 to 0.923, suggesting strong and uniform

relationships. Similarly, ENS indicators span from 0.805 to 0.888, PES from 0.781 to 0.863, and SUS from 0.745 to 0.892, all indicating robust connections.

To determine discriminant validity, the researchers used the Heterotrait-Monotrait (HTMT) and the Fornell-Larcker criteria, as suggested by Fornell & Larcker [75] and Henseler et al. [76]. There was favorable discriminant validity, as shown in Table 3. Based on Table 3, it is shown that the square root of the AVEs for all constructs presents larger values than their correlation coefficients, i.e., off-diagonal values. Further evidence of discriminant validity criteria is shown in Table 4, where HTMT values were also demonstrated below the cut-off point of 0.85 [76]. Consequently, the results support the investigation's validity and allow the researchers to move on to the next step. The following Table 3 shows the values from Fornell-Larcker criterion and Table 4 shows the values from the HTMT analysis:

Table 3. Discriminant validity (Fornell-Larcker criterion)

	ENS	IT	PEC	SUS
ENS	0.850			
IT	0.289	0.905		
PEC	0.314	0.300	0.810	
SUS	0.438	0.421	0.672	0.823

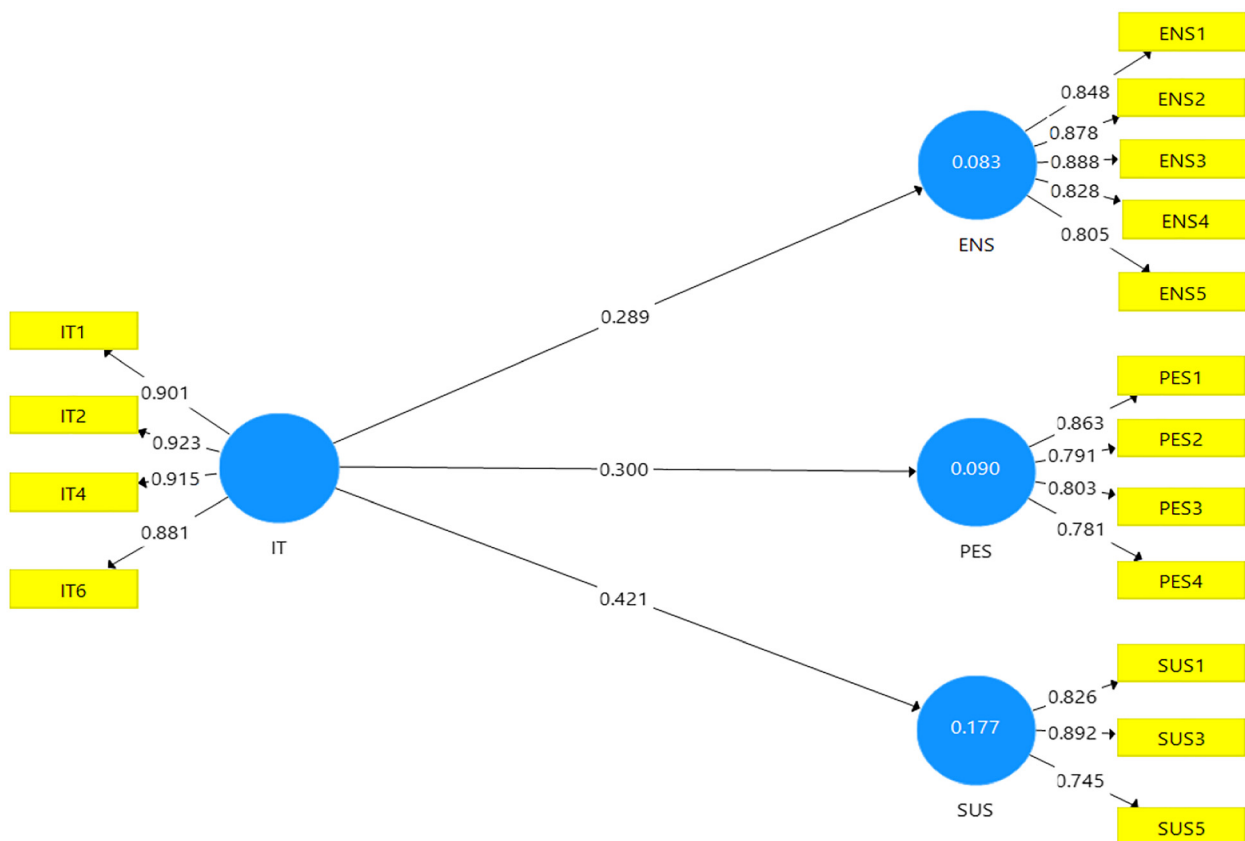


Fig. 3. Measurement model after conducting confirmatory factor analysis; Source: Smart-PLS 4

Table 4. Discriminant validity of HTMT ratio

	ENS	IT	PEC	SUS
ENS				
IT	0.309			
PEC	0.377	0.322		
SUS	0.517	0.467	0.551	

Notes: IT = Information Technology; ENS = Environmental Sustainability; PEC = Prevention from Environmental Crime; SUS = Promoting Sustainability; Source: Generated using SmartPLS 4.

4.3. Structure model

In order to evaluate the structural model of this study, and investigate the hypothesized relationships among the constructs, the researchers used PLS-SEM (version 4) software. In this stage of analysis firstly, the R^2 value was examined to measure the explanatory effectiveness of the present model. In this study, the value of R^2 , which represents the explanatory power of a predictor on the outcome construct, for ENS was 0.083; IT use represented 8.3 percent of the variance in environmental sustainability. Similarly, the value of PEC was 0.090 which represents 9.0 percent of the variance in environmental crime prevention is explained by IT use. Additionally, the R^2 for SUS was 0.177, implying that 17.7 percent of the variance in sustainability promotion was explained by IT use.

Furthermore, a blinding technique using exclusion distance was applied to assess the predictive relevance of the path model. It was found that Stone-Geisser's Q^2 values [77, 78] were above zero for all the endogenous constructs ($Q^2_{ENS} = 0.059$; $Q^2_{PES} = 0.054$; and $Q^2_{SUS} = 0.108$) of the pre-naturalized path model adopted in Table 5 [71]. The following Table 5 shows the predictive relevance and Table 6 represents the VIF values.

However, based on the suggestion of Mahmud et al. [72] and Amin and Rubel [64], if there is no issue of multicollinearity among all constructs and the VIF values are below 3.3, representing the reliability and validity of the

Table 5. Dependent variables' predictive relevance

Dependent Variables	R^2	Adjusted R^2	Q^2 Values
ENS	0.083	0.081	0.059
PES	0.090	0.088	0.054
SUS	0.177	0.175	0.108
ENS	0.083	0.081	0.059

Table 6. Constructs' VIF values

	ENS	IT	PEC	SUS
ENS				
IT	1.000		1.000	1.000
PEC				
SUS				

Note: VIF = Variance Inflation Factor; Source: Generated using SmartPLS 4.

constructs (please see Table 6). Thus, according to Table 6, the constructs of this study are acceptable.

4.4. Hypotheses testing results for direct effects

Afterwards, the weights and significance of the path coefficients were determined using a bootstrapping approach (one-tailed) by means of 5,000 sub-samples, as suggested by Edeh et al. [71]. Based on Table 7, the construct relationship paths from IT to ENS ($\beta = 0.289$; $P < 0.05$), IT to PEC ($\beta = 0.300$; $P < 0.05$), and IT to SUS ($\beta = 0.421$; $P < 0.05$) are substantially positive which represents statistically acceptable. Therefore, $H1$, $H2$, and $H3$ were accepted significantly.

According to the above-mentioned outputs, the researchers affirm that higher levels of IT usage cause a higher degree of favorable awareness towards environmental safety, prohibition of environmental crime, and promotion of sustainability among managers in e-commerce businesses in Bangladesh. The following Table 7 shows the results from the hypotheses test.

However, the following Fig. 4 shows the structural model including 'P' values.

Figure 4 illustrates complex relationships between various constructs and their indicators. At the center of the model is a construct labeled "IT" (Information Technology). This central IT construct is connected to several indicator variables, labeled IT1, IT2, IT4, and IT6, suggesting these are specific measurable aspects of the IT concept being studied.

From the IT construct, three paths emerge, leading to other constructs: ENS, PES, and SUS. Each of these has its own set of indicator variables. The model displays path coefficients and P -values for these relationships, all showing statistically significant connections ($P = 0.000$) between IT and the other constructs.

The path from IT to ENS has a coefficient of 0.289, to PES 0.300, and to SUS 0.421, indicating varying strengths of influence. These coefficients suggest that IT has the strongest effect on SUS, followed by PES, and then ENS.

Each of the endpoint constructs (ENS, PES, and SUS) is associated with multiple indicator variables. ENS has five (ENS1-ENS5), PES has four (PES1-PES4), and SUS has three (SUS1, SUS3, and SUS5). The numbers shown on the lines connecting these indicators to their respective constructs represent outer loadings, which indicate how well each indicator represents its construct.

Furthermore, the following Fig. 5 shows the structural model including the values from 'T' statistics.

Figure 5 represent T-statistics, which serve as measures of the statistical significance of the relationships between constructs. Higher T-values suggest stronger evidence against the null hypothesis of no relationship. The path from IT to SUS shows the highest T-statistic of 11.598, followed by the path to PES at 7.510, and finally to ENS at 6.462. These values, all being substantially higher than the typical threshold of 1.96, indicate robust and statistically significant relationships.

The model also reveals the strength of connections between each construct and its indicators through T-statistics. For instance, the link between IT and its second indicator

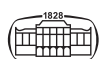


Table 7. Hypotheses testing (direct effects)

Hypotheses	Paths	Std. Beta	Std. Error	T Statistics	P Values	VIF	2.5% LLCI	97.5% ULCI	Decisions
H1	IT → ENS	0.289	0.292	6.462	0.000	1.000	0.199	0.386	Significant
H2	IT → PEC	0.300	0.308	7.510	0.000	1.000	0.230	0.381	Significant
H3	IT → SUS	0.421	0.428	11.598	0.000	1.000	0.354	0.496	Significant

Notes: IT = Information Technology; ENS = Environmental Sustainability; PEC = Prevention from Environmental Crime; SUS = Promoting Sustainability; LLCI = Lower Limit Confidence Interval; ULCI = Upper Limit Confidence Interval

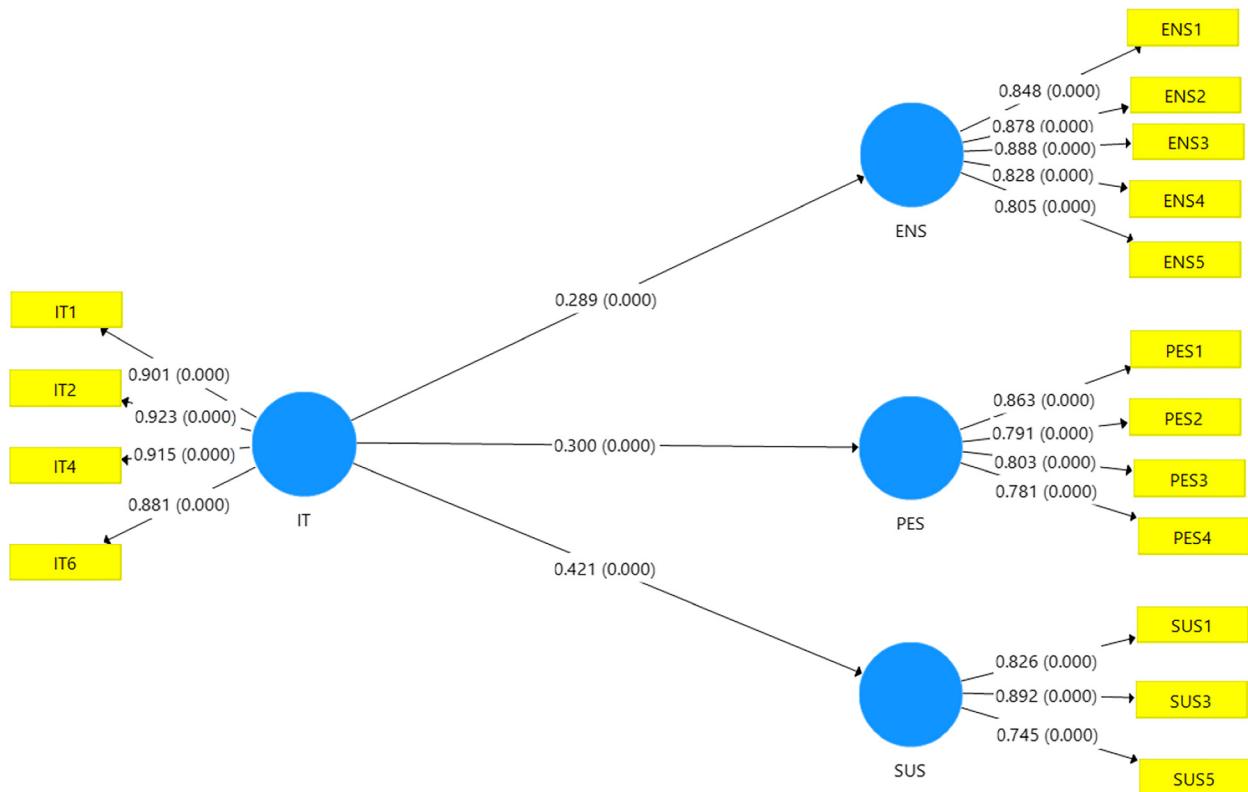


Fig. 4. Structural model including 'P' values; Source: Smart-PLS 4

(IT2) boasts an impressive T-statistic of 105.262, suggesting an exceptionally strong association.

5. DISCUSSION

The findings of the study's attempt to provide a thorough explanation of the outcomes were highly supportive of the measurement model's fitness through the item's reliability and construct validity. All constructs, i.e., variables, could fulfil the model's reliability criteria due to the model's acceptable internal validity as shown by alpha, CR, and AVE values, and the model falls within the proper threshold range. Table 7 shows the effects that were determined to be significant for the suggested structural model. The significance analysis was done using the results of the *t*-test.

Based on the data shown in Table 7 ($\beta = 0.289$, *T*-value = 6.462, *VIF* = 1.000, $P < 0.05$), the first outcome of this (IT → ENS) suggests that usage of information technology has a notable positive influence on environmental

sustainability [79]. Thus, the statistical value obtained from the study is used to derive this, points to a positive linear relationship between IT use and ecological sustainability. With a T-value of 6.462, we may conclude that there is a statistically significant correlation between IT use and environmental sustainability. The statistical significance of the relationship between the two variables is also confirmed by the *P* value, i.e., 0.000. Based on the *VIF* result, it seems that the latent variables do not have a significant multicollinearity issue. The results support H1, which states that e-commerce company managers in the studied nation have access to state-of-the-art IT resources, are proficient in their usage, and have approved them. Finally, the data shows that e-commerce businesses are open to new ideas and adept at using IT to become more environmentally sustainable. Doherty and Fulford [80] demonstrated that human error and non-compliance with environmental safety measures are often overlooked by organizations that do not prioritize policies developed by organizational policymakers. Consequently, awareness-raising initiatives and training on

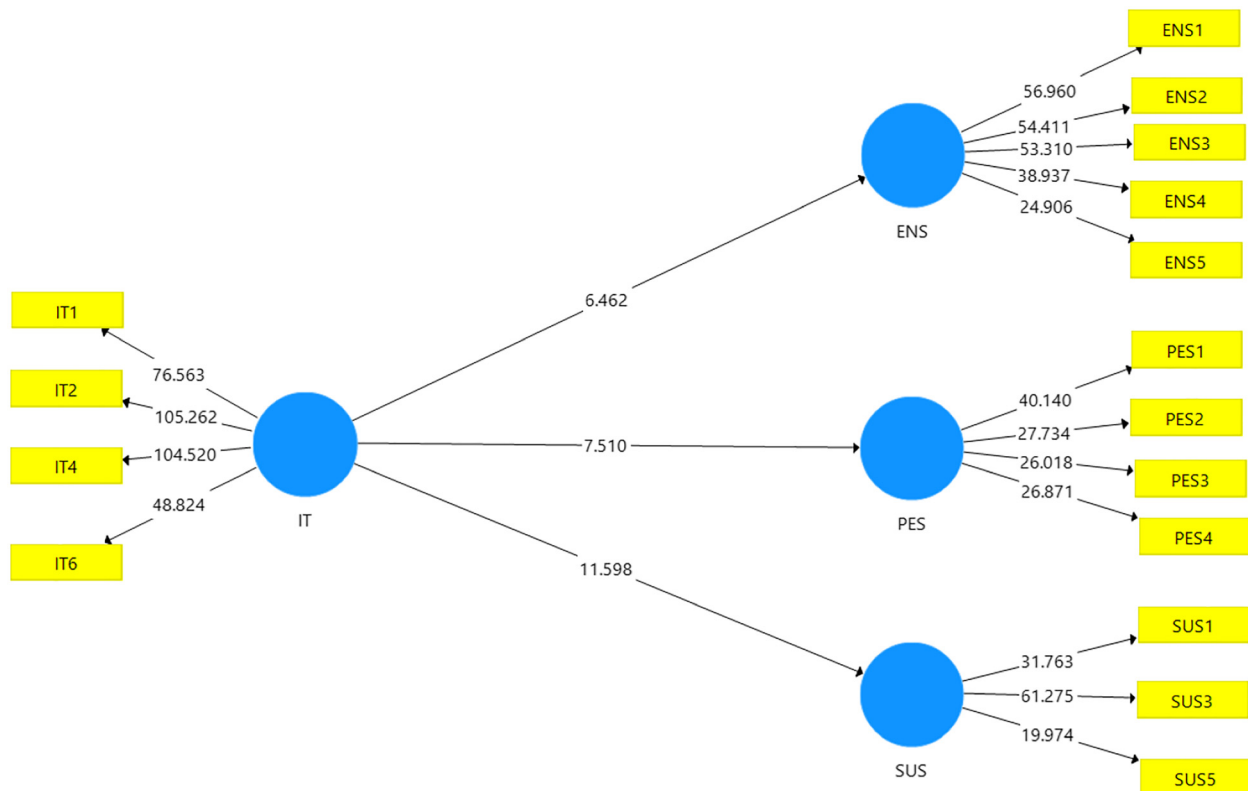


Fig. 5. Structural model including the values from "T" statistics. Source: Smart-PLS 4

these issues are rarely conducted. A significant portion of the difficulty can be ascribed to an absence of effective strategy at the managerial level.

Based on the recommendation of Sekaran & Bougie [81], the second finding of this study ($IT \rightarrow PES$) ($\beta = 0.300$, $T\text{-value} = 7.510$, $VIF = 1.000$, $P < 0.05$) implies that there is a positively significant relationship between the usage of IT and the prevention of environmental crime. The beta value shows that the usage of IT and the prevention of environmental crimes are positively and linearly related. A statistically significant relationship was determined between environment-related crime prevention and IT usage, as shown by the "t" value. The statistical significance of the link between the two constructs is also confirmed by the P value, i.e., 0.000. Thus, the **H2** is supported since the VIF result indicates that the independent variables do not exhibit any substantial multicollinearity. Hypothesis H2 is statistically significant and acceptable, representing that the management of Bangladesh's e-commerce corporations proved responsible and sincere for their online service commitments and for using IT to prevent all types of environmental crime. As a result, the above results suggest that e-commerce managers in emerging nations such as Bangladesh are dedicated to keeping up with the latest IT developments and presenting professional initiatives to safeguard their companies from environmental crimes. The present research also found similar results in line with what Wang & Shih [82] revealed in their investigation. In another similar research, Doherty and Fulford [80] indicated that the

organization's strategy and policy may efficiently manage environmental safety from various environmental crimes. They explained that the policy outlines the overall approach, while the process breaks it down into specific steps, which then create the procedure. Notably, safety professionals and organizational policymakers consider adequate environmental safety policy to be of utmost importance. Nevertheless, the insider threat concentrates on the factors that lead to the creation of an insecure environment and the approaches that may be used to enhance safeguarding and mitigate risks. The analysis of situations involving insider security breaches typically centers around the preventive procedures that target specific vulnerabilities [83].

The third finding of this study ($IT \rightarrow SUS$) indicates that information technology significantly contributes to sustainability ($\beta = 0.421$, $T\text{-value} = 11.598$, $VIF = 1.000$, $P < 0.05$). Based on the criterion of Sekaran & Bougie [81], the value of β is 0.421, a systematic regression factor demonstrating a robust positive linear connection among IS and sustainability promotion. A $T\text{-statistic}$ of 11.598 indicates a statistically significant correlation between IT use and sustainability promotion. If the $P\text{-value}$ is less than 0.000, demonstrating the correlation between the two constructs is statistically significant. **H3** is also supported since the VIF value of 1.000 indicates that the independent variables do not exhibit any significant multicollinearity. This finding lends credence to the third hypothesis, which states that the e-commerce managers of Bangladesh pay close attention to the sustainability metrics they track. They have

achieved remarkable stability while promoting its IT-related activities. Chan et al. [84] emphasized the critical role of information technology (IT) in promoting sustainability in manufacturing management. Their findings advocate for the integration of environmental and safety metrics alongside other key performance indicators (KPIs) into existing IT and management systems. Similarly, Hendricks and Singhal [85] suggested that companies should implement and synchronize environmentally friendly technologies and environmental manufacturing processes. On the other hand, Linton et al. [86] conducted an empirical investigation into sustainability, highlighting the extent to which technology can alleviate the challenges associated with sustainable resource use amid continuous economic growth.

However, there is a significant emphasis on green initiatives to minimize environmental harm and a growing demand for investigations into how information technology can support environmental sustainability and the benefits of investing in green IT initiatives [87]. While another study conducted by Yenipazarli & Vakharia [88] in information systems has made significant progress in understanding the impact of IT on performance, there is limited knowledge regarding the contribution of green IT to energy conservation and economic success.

6. IMPLICATION OF THE STUDY

The findings from this research offer a significant contribution to the intersection of e-commerce, information technology, and sustainability practices. By presenting a meticulously constructed research framework that examines the relationships within these domains, the study validates the Technology Acceptance Model (TAM) assumptions and provides insights into the role of e-commerce in enhancing ecological safety and sustainable business operations.

1. **Practical Implications for Businesses:** Organizations that are involved in e-commerce may take advantage of information technology to enhance resource management efficiency, resulting in reduced waste production and improved overall effectiveness. Implementing digital platforms, cloud computing solutions, and all other usages of IT can enhance organizational sustainability by decreasing the need for physical infrastructure and paper-based operations. Additionally, the data analytics technologies additionally save energy, improve resource conservation, and further reduce energy consumption.
2. **Strategic and Policy Implications:** The study emphasizes the significance of integrating IT in the e-commerce sector to improve environmental performance, promoting resource conservation, reducing carbon emissions, and enhancing energy efficiency, thus enabling proactive environmental issues.
3. **Implications for Organizational Efficiency:** IT-based e-commerce solutions can enhance organizational efficiency by streamlining processes, improving communication, decision-making speed, and reducing operational costs while aligning with eco-friendly practices.

4. **Contributions to Research and Future Studies:** This study explores the relationship between IT usage and sustainability in Bangladeshi e-commerce organizations, providing a foundation for future research on global implications and optimizing IT strategies to support environmental objectives.

Overall, the study provides valuable insights for businesses, policymakers, and academics to improve sustainability, promote greener economies, and explore technology-environmental stewardship in e-commerce.

7. CONCLUSION

This study utilizes PLS-SEM to analyze the impact of IT usage on environmental safety, sustainable practices, and incident avoidance using a large dataset from the managers of e-commerce organizations. This research employs rigorous statistical methodology to assess the reliability and validity of the measurement and structural models. The key findings of this investigation have been outlined below:

1. The investigation revealed that there exists a positive and statistically significant correlation between the utilization of information technology (IT) and favorable perceptions towards environmental safety, prevention from environmental crime, and sustainability within the realm of e-commerce enterprises in Bangladesh.
2. The scholars ascertained that a higher level of IT utilization results in a greater degree of favourable perception regarding environmental safety, crime prevention, and sustainability among the executives in e-commerce enterprises.
3. The employment of information technology facilitates more efficient monitoring and management of resources, thereby leading to reduced inefficiency and heightened effectiveness.

Our research reveals a positive and significant link between IT adoption and eco-friendly practices within the e-commerce industry. Additionally, the study delves deeper by providing a comprehensive profile of the demographics behind these practices, including the age, education level, and experience of e-commerce managers.

However, it is crucial to acknowledge certain limitations. The study area is limited to Bangladeshi e-commerce sector. This may not reflect the global nature of e-commerce and the diverse environmental and criminal landscapes across different sectors. Though the results offer valuable insights into the current context, we must exercise caution in generalizing findings beyond the studied demographic. Nevertheless, this study focuses on quantitative data analysis and representation, whereas future scholars may carry on qualitative studies in the similar research area.

This research leads to the existing literature by establishing empirical evidence of the nexus within IT utilization and environmental sustainability in a rapidly evolving e-commerce landscape. The study's outcomes carry implications for both academia and industry, offering a foundation



for future research endeavors aimed at understanding and fostering sustainable practices in digitalized business environments. Furthermore, the research findings will act as a beneficial resource for organizations and researchers seeking to understand the relationship between IT usage and environmental sustainability practices in the e-commerce sector.

Importantly, Information Technology empowers e-commerce enterprises to minimize their environmental impact and actively support sustainability initiatives. By streamlining procedures and reducing reliance on physical resources, IT not only simplifies processes but also aligns businesses with eco-friendly practices. Eventually, the strategic incorporation of IT in e-commerce not only enhances resource management and reduces waste but also promotes environmentally sustainable practices, thus substantiating its pivotal role in supporting sustainability efforts.

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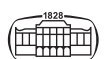
Declaration on competing interests: The authors declare that they have no known competing financial interests or personal conflicts that could have appeared to influence the work reported in this paper.

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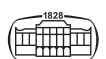
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APPENDICES

Appendix-1: Questionnaire constructs and items

Constructs and items

Information Technology Usage (তথ্য প্রযুক্তির ব্যবহার)

The usage of IT application save my time, energy, and increase my productivity
The usage of IT application is environment friendly and protective

The usage of IT helps me to create new ideas
The usage of IT helps to increase managerial activities
The usage of IT helps me to take managerial decisions
The usage of IT improves the capabilities of managerial control
Source: 29

Environmental Safety (পরিবেশগত নিরাপত্তা)

I have enough knowledge in environmental safety
I have necessary competency to save my atmosphere from any accident
I have all kinds of safety equipment to save myself and my surroundings from any accident
I am concerned about the environmental safety issue
I have sufficient training with regard to work environment
Source: 30

Prevention from Environmental Crime (পরিবেশগত অপরাধ থেকে প্রতিরোধ)

I am always aware of using high technology to secure myself from environmental crimes
I am concerned about information or data manipulation
We are protected from environmental fraud scams
Our data are protected from all environmental threats
Our technologies are protected from all environmental threats
Source: 31

Promoting Sustainability (স্থায়িত্বের প্রচারমূলক কার্যক্রম)

I have enough knowledge about sustainability
Our organization reduces wastage than before
We have reduced energy usage than previous time
We have maximised the energy saving
Our company is in good position to sustain
Source: 32

আইটি অ্যাপ্লিকেশনের ব্যবহার আমার সময়, শক্তি বাঁচায় এবং আমার উত্পাদনশীলতা বাড়ায়
আইটি অ্যাপ্লিকেশনের ব্যবহার পরিবেশে বান্ধব এবং প্রতিক্ষামূলক
আইটি ব্যবহার আমাকে নতুন ধারণা তৈরি করতে সাহায্য করে
আইটি ব্যবহার ব্যবস্থাপক কার্যক্রম বাড়াতো সাহায্য করে
আইটি ব্যবহার আমাকে ব্যবস্থাপনাগত সিদ্ধান্ত নতুন সাহায্য করে
আইটি ব্যবহার ব্যবস্থাপক নিয়ন্ত্রণের ক্ষমতা উন্নত করে

পরিবেশগত নিরাপত্তা বিষয়ে আমার যথেষ্ট জ্ঞান আছে
আমার বায়ুমণ্ডলকে যেকোনো দূষণ থেকে বাঁচানোর জন্য আমার প্রয়োজনীয় দক্ষতা রয়েছে
যেকোনো দূষণ থেকে নিজেকে এবং আমার আশেপাশের পরিবেশকে বাঁচাতে আমার কাছে সব ধরনের নিরাপত্তা সরঞ্জাম আছে
আমি পরিবেশগত নিরাপত্তা সমস্যা সম্পর্কে উদ্বিগ্ন
কাজের পরিবেশে সম্পর্কে আমার যথেষ্ট প্রশিক্ষণ আছে

পরিবেশগত অপরাধ থেকে নিজেকে সুরক্ষা রাখতে উচ্চ প্রযুক্তি ব্যবহার করার ব্যাপারে আমি সবসময় সচতেন
আমি তথ্য বা ডটো ম্যানিপুলেশন সম্পর্কে উদ্বিগ্ন
আমরা পরিবেশগত জালিয়াতি স্ক্যাম থেকে সুরক্ষা
আমাদের ডটো সমস্ত পরিবেশগত হুমকি থেকে সুরক্ষা
আমাদের প্রযুক্তিগত সমস্ত পরিবেশগত হুমকি থেকে সুরক্ষা

স্থায়িত্ব সম্পর্কে আমার যথেষ্ট জ্ঞান আছে
আমাদের প্রতিষ্ঠান আগের তুলনায় অপচয় কমায়
আমরা আগের সময়ের তুলনায় শক্তির ব্যবহার কমিয়েছে
আমরা আমাদের সবচেয়ে শক্ত সুরক্ষা করছে
আমাদের কর্মীরা টেকসই ভাল অবস্থানে আছে



Appendix-2: Common Method variance/Biasness test

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.687	31.842	31.842	6.687	31.842	31.842
2	3.110	14.810	46.652			
3	2.425	11.549	58.201			
4	1.262	6.011	64.212			
5	1.099	5.232	69.444			
6	0.956	4.554	73.998			
7	0.665	3.169	77.166			
8	0.609	2.898	80.065			
9	0.589	2.806	82.871			
10	0.479	2.280	85.150			
11	0.453	2.159	87.309			
12	0.436	2.074	89.383			
13	0.349	1.661	91.044			
14	0.322	1.534	92.577			
15	0.312	1.486	94.063			
16	0.280	1.334	95.397			
17	0.262	1.250	96.647			
18	0.229	1.090	97.737			
19	0.207	0.988	98.725			
20	0.151	0.721	99.446			
21	0.116	0.554	100.000			

Extraction Method: Principal Component Analysis.

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