

A Study to Analyse the Critical Determinants of Implementing Green ICT for Sustainable Development

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ABSTRACT Information and communication technology, sometimes known as ICT, may be found in almost every aspect of human endeavor. A study must be conducted to demonstrate the environmental damage caused by these items in order to restrict their widespread use. Many studies have widely stated that there is a stronger connection among technologies that support the greater good. This study focuses on analyzing the critical determinants of implementing new technologies that support sustainable development. The application of key technologies such as Green ICT, the Internet of Things, Big Data, etc., is driving a growing need for advancements across business, commerce, community development, and other areas that require attention. Through the application of such innovative technologies, it will be easy for the government to manage overall operations and support sustainable development in an effective manner. The application of comprehensive related policies tends to shape future generations; this is considered a key aspect for enhancing the overall development of communities and nations at large. Various technologies are being applied that will help nations effectively use natural resources, engage in better trade relations, reduce waste, and focus on reducing overall carbon footprints, etc. Hence, this study is more focused on analyzing the critical determinants of the application of sophisticated technologies in achieving overall sustainable development.

Keywords: Green ICT, Sustainable Development, Regression.

1. Introduction

The world is witnessing a sea change due to the application of different technologies across many areas, with the single goal of realising sustainable development. The rules of the nations are rewritten through the implementation of these technologies, which effectively and efficiently support understanding of the critical areas that need more attention, so that the nations can realise their goals. The development of such sophisticated technologies enables monitoring the nation's development through effective resource allocation, ensures the smooth functioning of government enterprises, supports business and commerce, and helps communities grow. It has been noted that the success factor depends on the effective functioning of all areas covering environment, social, and governance, which will lead to sustainable development. The application of these technologies ensures better functioning of these areas, identifies waste and eliminates it, enabling the nation to work effectively and reducing pollution and the use of energy resources for sustainability.[1]. To achieve the stated growth, it is vital to focus on investments that will generate better returns and unlock new avenues of growth, providing more opportunities for people. The single objective of sustainable development will enable the creation of a better economy that uses various factors, supports communities in effectively using the resources they possess, understands the growing needs of the population, and manages them better. [2]. Also, it is essential to understand the application of technologies that do not impact the environment or

increase the country's carbon footprint. Hence, it is very important to use technology with great care for the environment and ensure that the government can achieve key areas of growth and development [3]. Many researchers have highlighted that the overall importance of using technologies is to create more opportunities internally, effectively use resources for the greater good, eliminate waste, reduce poverty, and achieve inclusive growth [4]. Progress in digital technology has emerged as a primary driver of long-lasting change. In addition to ensuring that organizations remain profitable and viable over the long term, researchers indicate that digital transformation contributes to sustainability by fostering positive outcomes in social and environmental sustainability [5]. Because the information and communications technology business uses hardware and software to monitor and protect the environment, it is distinct from other industries: it safeguards the environment while simultaneously causing environmental damage [6]. The Internet of Things (IoT) is everywhere (in people, companies, and society) and is essential to advancing both the economy and society. There has been different cases which will focus in understanding the critical issues which are being currently faced by the government like depletion of the natural resources, understanding the issues related to water scarcity, increase in overall energy costs etc, which all these factors Mismanagement on a systemic level and unequal distribution of resources are usually to blame for global environmental issues such as the depletion of resources, the scarcity of water, and the rising cost of energy. As greenhouse gas emissions have increased, these problems have become even more severe. Both the economy and the ecology are thus at risk of instability. However, as technological advancements occur rapidly and the social and environmental context evolves, it is imperative that we continually investigate how digital technology impacts sustainable development [7]. The continuous advancement of digital technology is revolutionizing the way we learn and live. Innovations that are sustainable and environmentally friendly aim to produce one-of-a-kind, high-quality products with a much lower environmental impact. As long as environmental issues persist, an increasing number of people will realize how critical it is to find solutions that are both sustainable and environmentally friendly. [8]. The use of digital technology is a valuable tool for developing novel concepts of sustainability. Using data and analytics, we can identify patterns and devise more effective solutions to societal and environmental issues. To make full use of this potential, it is essential to have a comprehensive and up-to-date understanding of how digital technology impacts individuals. Because it makes it easier to work from home, interact with others, and collaborate from a distance, environmentally friendly information and communication technology is particularly significant for reducing pollution. When it comes to safeguarding the environment and boosting the economy, sustainable green technologies help create a more sustainable society. Using digital technology makes it easier to base decisions on data, which in turn improves resource management and encourages individuals to be more ecologically responsible. At the same time, it makes it easier for individuals to participate in environmentally beneficial initiatives in their areas. By making these efforts, fuel is saved, pollution levels are reduced, and traffic congestion is alleviated. People spend less money on their commutes as a result, and the city saves money on health care costs associated with pollution, as well as on infrastructure maintenance.

2. Review of Literature

Many studies examine various aspects of environmentalism. The purpose of this study is to analyze the conceptual frameworks associated with the Sustainable Development Goals (SDGs) and the logic that underlies them. Important concepts such as uncertainty, irreversibility, and the principles for locating critical turning points are given great emphasis in this article. According to a study investigating the contextualization of global goals at the national level, the baselines and indicators of the objectives have not been adequately used in the process of urban development. A substantial amount of emphasis was placed on developing regional indicators for the Sustainable Development Objectives [10], with the goal of achieving more detailed final objectives.

Achieving the United Nations Sustainable Development Goals (SDGs) has a particularly significant impact. Through the promotion of technologies that generate renewable energy and make more efficient use of resources, the Global Trade Initiative (GTT) is actively advancing Sustainable Development Goal 7, which aims to ensure that energy is both affordable and clean. By establishing a framework for organizational structure, businesses operating in the global industrial sector have been assisted in understanding the risks associated with generating environmentally beneficial ideas [11]. Three approaches were used to explore the possible risks associated with environmentally friendly industrial improvements across the global value chain. Four types of danger were identified throughout the course of green innovation. Green research and development, green manufacturing, green marketing, and green service are all examples of these hazards. Given these dangers, it is essential to investigate how indicators respond and change during developmental oscillations. [12]. The method used for sustainable urban development emphasizes the need to preserve the natural environment while simultaneously fostering economic growth. The economic component of sustainability emphasizes the need to establish economies that are both stable and growing, while also reducing environmental damage and protecting resources [13]. Through the application of this system, the effective use of resources, the development of environmentally friendly technologies, and the adoption of business practices that benefit both the economy and the environment are strongly encouraged. Real-time data analytics are necessary for municipal planning and administration to support successful smart urbanization [14]. By using this data-driven approach, activities such as traffic management, garbage collection, and public service provision become more efficient, resulting in a direct reduction in pollution. Fairness, social justice, and the well-being of every individual are the core principles that underpin social sustainability. The concept at hand concerns the extent to which a society can effectively preserve and improve its members' standard of living over time. To ensure everyone has the same opportunities, protects human rights, and guarantees everyone has a home worthy of respect, it is essential to offer everyone the same chances. Utilizing technology alone should not be the only component of digital transformation. Instead, it should be seen as a planned process centered on the company, with the objective of enhancing the organization's operational efficiency and making it more innovative and competitive. In most cases, it is essential to alter the way work is performed while simultaneously enhancing it and converting it to a digital format. The majority of the time, businesses of all sizes use cloud computing services not because their workers like them, but because they are required to do things such as ensure the safety of their employees' data and provide them with access to it. Often, the mistaken notion that storage is limitless is supported by the regulations governing corporate data. As a result, significant amounts of data are stored, either because employees are concerned about future data demands or because there are no clear regulations governing data storage. Research conducted in the real world has not yet fully understood the connections between environmentally friendly intelligent urbanization and environmental degradation. The research gap arises because insufficient research has been conducted on the relationship among various aspects. When businesses are prepared to adapt to changes in environmental rules, they may be able to secure a monopoly for a limited period. This is particularly true in the realms of information and communication technology (ICT) and technical advancement, both of which are expanding rapidly. According to findings from several studies, the use of information and communication technology (ICT) in urban transportation may simultaneously contribute to environmental preservation. On the other hand, previous research has not clearly examined the full impacts of green information and communication technology (ICT) and smart urbanism on environmental degradation. The adoption of market-driven techniques to combat climate change is becoming increasingly popular due to limitations. Consequently, companies are dedicating greater attention to becoming environmentally friendly. Some purchasers in the information and communications technology industry are even instructing their suppliers to reduce the environmental impact of their goods and the manufacturing processes used to produce them.

3. Methodology

This research uses a quantitative, descriptive and analytical research design to investigate the relationship between an organization's environmental commitment, smart urbanization, regulatory and policy pressure, market and stakeholders' environmental expectations and sustainable development. The study involved the collection of primary data through a Likert scale questionnaire from a 70-100 sample using convenience sampling of stakeholders and practitioners in ICT and sustainable development. Primary data were examined statistically using Pearson correlation to examine relationships, logistic regression to measure the effects of the dependent variables, and independent sample t-tests to compare groups. Data analysis was performed using SPSS and statistical significance was evaluated at the 1% level.

4. Results

The results of correlation analysis are given in Table 1. There is a strong positive relationship between organizational environmental commitment and regulatory and policy pressure ($r = 0.927$). So, firms that care deeply about protecting the environment are likely to follow strict rules. There is a significant correlation ($r = 0.823$) between the degree to which an organization is concerned about the environment and the length of time it will continue to exist. When it comes to achieving its long-term sustainability goals, it is abundantly clear that a firm's fundamental values are critical. The findings of this study highlight the significance of intelligent urban systems for protecting the environment and promoting the health of society and the economy. There are a number of reasons for this, including that they use less energy, allow you to see data in real time, and simplify the process of providing services. A variety of policy and regulatory variables significantly influence ICT projects in cities. This assertion is unquestionably supported by the robust correlation ($r = 0.888$) between the architecture of smart cities and the two qualities. By pushing the boundaries of technology and improving the quality of life for all people, innovative city projects aim to make the world a better place. There is a substantial link ($r=0.864$) between regulatory and policy pressure and sustainable development. This shows how strong environmental laws can compel cities and businesses to do things that are good for the environment. This website explains how people can use green information and communication technology to conserve energy, reduce pollution, and better use resources. The expectations of the market and stakeholders for the environment and sustainability go hand in hand. The correlation's value is 0.840. As businesses prepare for sustainability, the activities of investors, customers, and supply chain partners are having a greater and more obvious impact on them.

Table 1. Correlation analysis

Correlations	Organizational Environmental Commitment	Smart Urbanization	Regulatory and Policy Pressure	Market and Stakeholder Environmental Expectations	Sustainable Development
Organizational Environmental Commitment	1	.845**	.927**	.830**	.823**
Smart Urbanization	.845**	1	.888**	.830**	.865**
Regulatory and Policy Pressure	.927**	.888**	1	.850**	.864**
Market and Stakeholder	.830**	.830**	.850**	1	.840**

Environmental Expectations					
Sustainable Development	.823**	.865**	.864**	.840**	1

The results of Logit Regression analysis are shown in Table 2. The model that only includes the intercept has a -2 Log Likelihood of 302.411, indicating it doesn't explain anything. The new model produced by this method had a -2 Log Likelihood of 62.301, substantially lower than the old one. Regarding the probability ratio, the chi-square value of 240.111 indicates that 48 distinct outcomes may occur. With a significance level of 1% ($p = 0.00$), this is of comparable importance. The model demonstrates that it is effective in general since the amount of variation that cannot be explained has decreased significantly. It demonstrates that throughout the process of selecting goals for sustainable development, it would be beneficial to consider aspects associated with organizations, cities, laws, and markets. Both Stakeholder Environmental Expectations and Market Expectations are predictive, as demonstrated by the model ($\chi^2 = 16.526$, $df = 8$, $p = 0.04$). To make progress in the field of sustainable development, environmentally friendly information and communication technology is becoming an increasingly important factor. The dynamics of the market, consumer awareness, and stakeholder participation are becoming increasingly crucial. The findings of this study demonstrate that the requirements and desires of consumers, investors, supply chain partners, and society as a whole have a significant impact on how companies operate effectively. When it comes to making decisions that will affect a longer-term period, these criteria and expectations often take priority over the sustainability standards and promises made throughout the organization.

Table 2. Logit Regression analysis

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	p value
Intercept Only	302.411			
Final	62.301	240.111	48	0.00
Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	62.301a	0	0	
Organizational Environmental Commitment	68.846b	6.546	8	0.59
Smart Urbanization	75.402b	13.102	8	0.11
Regulatory and policy pressure	66.470b	4.169	4	0.38
Market and Stakeholder Environmental Expectations	78.826b	16.526	8	0.04

The independent-samples t-test (Table3) shows that organizational environmental commitment is significantly different from the other groups studied. The F value of 0.016 indicates that Levene's test supports the assumption of equal variances. This interpretation says that the differences in the row make sense when you look at them together. The statistically significant t-value of -18.894 with 71 degrees of freedom ($p = 0.00$) indicates that the groups studied had very different average levels of commitment to the work environment. The fact that the F value is 0.016 indicates that Levene's test supports the hypothesis that the variances are identical. According to this perspective, the discrepancies in the row are immediately apparent when the whole is considered. The t-value of -18.894, which is statistically significant with 71 degrees of freedom ($p = 0.00$), demonstrates that the investigated groups had substantially different average levels of commitment to the work environment. This is the conclusion that can be drawn from the data. The difference in mean scores (- 2.99) indicates that one group is much less concerned about environmental preservation than the other. The standard error of the difference (0.158) is small, indicating that the mean difference is accurate and that the difference is highly significant. The mean difference certainly lies between -3.306 and -2.675. Because this range does not include zero, statistical evidence indicates a meaningful difference between the groups, rather than being due to random sampling. Considering that the confidence interval and the mean difference are quite close to one another, the significance level of the t-value, which is -18.485, is extremely high ($p = 0.00$). In the context of green information and communication technology implementation and sustainable development, this research highlights the importance of organizational commitment as a critical variable that influences the level of preparation and involvement in environmentally friendly information and communication technology activities.

Table 3. T Test 1

Organizational Environmental Commitment	F	Sig.	t	df	P value	Mean Difference	Std. Error or Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	0.016	0.9	-18.894	71	0.00	-2.99	0.158	-3.306	2.675
Equal variances not assumed			-18.485	15.337	0.00	-2.99	0.162	-3.335	-2.646

There are 84 degrees of freedom in the t-statistic, and its value is -51.399, as shown by the revised assumption shown in Table 4. Given the p-value of 0.00, the results are statistically significant at the 1% level. When it comes to smart urbanization, the two organizations' approaches differ significantly. One group is much less interested in or involved in creative urbanization projects than the other, as shown by the mean difference of -2.659 between the two groups. Because the standard error is lower than 0.052, we can be certain that the difference is genuine. On the other hand, the 95% confidence interval ranges from -2.762 to -2.556. The difference between these two values is comparable on average. Given that 0 does not fall within this range, the difference is far more significant when viewed statistically. This demonstrates that the several methods of estimation are comparable in terms of consistency. This substantial gap demonstrates that residents are not consistently using IT-enabled urban solutions, highlighting a critical deficiency in Green ICT and sustainable development. This may alter how efficiently resources are utilized, how long they tend to survive, and how much damage they do to the ecosystem.

Table 4. T Test 2

Smart Urbanization	F	Sig.	t	df	P value	Mean Difference	Std. Error or Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	26.125	0.0	-9.602	86	0.00	-2.659	0.277	-3.209	-2.108
Equal variances not assumed			-51.399	84	0.00	-2.659	0.052	-2.762	-2.556

A substantial difference between the groups was found in the results of the independent-samples t-test for Regulatory and Policy Pressure shown in Table 5. With a significance level of 0.00, Levene's test yields a p-value of 90.689, indicating that the variances are not equal. This is because the significance level is 0.00. Following the implementation of this modification, the t-value of -53.785, with 97 degrees of freedom, was found to be statistically significant at the 1% level ($p = 0.00$). This case shows that regulatory and policy bodies have varied effects on different groups. The difference in means, -2.633, indicates that one group is much more affected by laws and regulations than the other group. Because the standard error of the difference (0.049) is rather low, the measurement is likely correct. Because it makes more sense, the outcome is more plausible. At the 95% confidence level, the mean difference is estimated to lie between -2.73 and 2.536. Using a t-test with independent samples, we determined that there were statistically significant differences between the two groups for both the Market and Stakeholder Environmental Expectations. With an F-value of 0.070 and a p-value of 0.792, Levene's test for equal variances demonstrates that the assumption of equal variances is correct. The existence of a valid hypothesis shows this. Based on the collected data, this interpretation assumes equal variances.

Table 5. T Test 3

Regulatory and Policy Pressure	F	Sig.	t	df	P value	Mean Difference	Std. Error or Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	90.689	0.0	-14.31	103	0.00	-2.633	0.184	-2.998	-2.268
Equal variances not assumed			-53.785	97	0.00	-2.633	0.049	-2.73	-2.536

Given 69 degrees of freedom and a t-statistic of -18.017, we can conclude that the data are statistically significant at the 1% level ($p = 0.00$) in Table 6. The perspectives of the two groups on the market and on stakeholders' environmental objectives are quite different. The fact that one group has much lower expectations for the environment from stakeholders and markets is shown by the negative mean difference of -3.276. Compared to the last case, this one is quite different. We are certain that the observed mean difference is accurate, as the standard error of the difference is very small (0.182).

Table 6. T Test 4

Market and Stakeholder Environmental Expectations	F	Sig.	t	df	P value	Mean Difference	Std. Error or Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	0.07	0.792	-18.017	69	0.00	-3.276	0.182	-3.639	-2.913
Equal variances not assumed			-16.996	8.605	0.00	-3.276	0.193	-3.715	-2.837

The mean difference might range from -3.639 to -2.913, with -2.913 being the highest possible value. Because the sole number shown is zero, the difference is statistically significant. Since the difference remains significant within the same confidence interval, the findings obtained with unequal variances are more credible than those obtained with regular variances. In the context of companies operating in green information and communication technology and sustainable development, this conclusion demonstrates the importance of external market demands and stakeholder expectations. The findings indicate that people's perspectives on external factors may significantly influence the extent to which businesses implement and value environmentally friendly information and communication technology practices.

5. Discussion

On the basis of these concepts and the current circumstances, the purpose of this endeavor was to devise a strategy for more effectively managing environmentally friendly information and communication technology (ICT). To investigate the challenges and opportunities the city of Barreiro faces, this study used a strategy that was not only original but also straightforward and comprehensive. The Data Classification and Retention Policy appears to be the first stage in establishing a method for organizing data by type (e.g., written documents, audio recordings, or films) and by frequency of use. In the system, users can choose various retention periods for each category. Files that aren't read often may be archived or deleted automatically by the system thanks to this feature. By doing so, unnecessary space and energy are conserved. To reiterate, these are the specific ways in which various technological systems are distinct from one another. Following the completion of the fundamentals, the next stage in using information and communication technology with an eye toward the environment is to investigate the specific components involved. When the recommended analytical method is included in a framework that takes use of cross-sector integration, local (regional) traditions and strengths, involves stakeholders, and grants power to local organizations, it makes perfect sense to do so.

6. Conclusion

By gaining an understanding of how other countries use technology and the rates at which they do so, we may determine which factors contribute to or hinder sustainable development. Digital efforts that succeed in wealthy cities may struggle to convince people to adopt them in rural or economically disadvantaged areas. To facilitate city growth in a manner consistent with common sense, the government must enact laws and regulations. In addition, it is necessary to ensure that environmentally friendly information and communication technology (ICT) is used and maintained effectively and sustainably. Among them are establishing guidelines for the proper disposal of digital waste, reducing energy use, and constructing infrastructure designed to withstand.

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