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The Influential Factors of Green IT Adoption in Data Centres of Sri Lankan Banks

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ABSTRACT

The growing concern on environment sustainability, increasing fuel prices and climate change have galvanised business and government organisations to incorporate the Green concepts in all areas. Green IT is an emerging research area in Information Technology field. As IT infrastructure is growing rapidly in Sri Lanka, it is evident that Sri Lanka too would face major issues with energy prices and e-waste. Increasing energy cost is already a major concern in business organisations in Sri Lankan. Thus, study on Green IT adoption in Sri Lanka is an area of interest to academics as well as business organisations. Hence, in this research, influential factors of Green IT adoption in data centres of Sri Lankan banks were studied. To achieve the objective a conceptual model based on literature was developed and four banks were selected for data collection. The results show that there is a high positive relationship between Green IT adoption and technological factors, organizational factors and the external pressure.

Keywords: *Data centres, Green IT, Technology adoption*

1. INTRODUCTION

"Global Warming", "Green House gases" ,"Climate change" and "Carbon foot print" are becoming common terms in daily news and science reports[1]. There are growing concerns in business and government organisations to reverse the adverse effects of environmental degradation. Green technologies have potential to positively impact on the environment degradation and sustainability.

The contribution of Information Technology (IT) towards the improvement of quality of life and economic growth is immense. IT has a potential to change the environment effects significantly [2]. It has been estimated that IT electricity consumption is roughly 3% of global electricity generation [3]. Hence, IT infrastructure contributes to a certain extent in green house gases emission. EPA estimates that 1.5% of total electricity is consumed by data centres.

Green computing, Green IT, Green ICT (Information and Communication Technology) and Green IS (Information Systems) are widely used terms for sustainable IT with few deviations. According to A. Molla et al. [4] Green IT is an ability of an organization to deploy environment sustainable criteria for IT infrastructure life cycle. There are two broad categories where Green IT is applicable. First one is reducing the adverse effect of IT to the environment. Mainly, the power consumption of IT equipment and associated utilities and waste disposal are the IT related adverse effects. The second category is utilizing IT resources to minimize the environmental adverse effects from other processes.

Business organizations are benefited by Green IT in multiple ways. R Bose et al. [5] pointed out some of the benefits including, reduction in power consumption, cost saving, reduce carbon emission, environment impact, improvement in systems performance, space saving, and an agile workforce.

Empirical studies have been conducted in many countries including Japan, South Korea, USA and Denmark [2] on how IT can be made sustainable. However, there are no such studies done in Sri Lanka. Therefore, the objective of this research is to investigate the influential factors of Green IT adoption in Sri Lankan banking sector data centres and how they affect the level of Green IT adoption.

The paper proceeds as follows: In section II, adoption theories related to this research and the link between Green IT adoptions is discussed. In section III, research methodology, including conceptual frame work, population and sampling, and data analysis are presented. Finally the results followed by conclusions, research limitations, and recommendations for future research is discussed.

2. LITERATURE REVIEW

The literature on Green IT is more recently developed and there are many areas still needed to be developed further [6]. Similarly, A Molla [7] pointed out that, Green IT is an emerging research field, and there is virtually very little academic research on the topic. They have identified research gaps in the field of Green IT and suggested frameworks for Green IT research. Green IT related literature can be found in various academic disciplines ranging from, technology, management, environment, sustainable development and psychology. In this research study, literatures in Green IT adoption, technologies, practices, and data centres are reviewed.

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2.1 Green IT definition

Different people imply many things for 'Green IT' [4]. A Molla et al. [4] further pointed out that Green IT is not a well defined concept, and there are no well accepted set of practices or technologies. According to S Murugesan's [8] definition, there are three main areas to be focused, when studying, practicing, designing, manufacturing and using IT equipments. They are Efficiency, Effectiveness and minimal impact to the environment. S Murugesan's [8] definition is focused on the tangible IT hardware. This definition lapses in organizational perspective and contribution of IT for greening the other disciplines. More Organizational oriented definitions are given by M. O'Neil[9] and S Mingay[10]. M O'Neil [9] defined Green IT as a reduction of carbon foot print within an organization by deploying initiatives which are desirable and strategic. S Mingay [10] gave compendious definition for Green IT. According to S Mingay [10], Green IT is optimal usage of IT for environment sustainability within an organizations operations and supply chain, and over and above to that of products, services and resources, throughout the duration of their life cycle. The above definitions can be classified into two broad categories. The first one is managing IT in such a way that to minimize the environmental impact. The second type is the use of IT to reduce the environmental impacts of non IT activities. S Mingay's [10] definition covers both the areas while other definitions focus on only one area.

2.2 Green IT Adoption and Models

Definitions of adoptions mainly focus on new innovation adoptions by organizations. Using those definitions, Green IT frameworks have been derived by researchers. According to E M Rogers [11] new innovation has 3 steps process; Create and attitude towards innovation, Decision to accept or reject new innovation, and Confirm the decision. The IT adoption models were developed using empirical research were based on different perspectives [7]: institutional perspective, managerial action perspective, and technological perspective.

E G Olson [1] pointed out that adoptions of Green technologies are similar to other technologies to some extent, but there are several differences. According to E G Olson [1] the differences between green initiatives and the traditional initiatives are : the start up cost is high and therefore, the time taken to reach breakeven is higher, employee morale, community goodwill and lower attrition, The product differentiation can be easily achieved and easier to sustain, legislative actions and government incentives may contribute to the value proposition, and new challenges will come up as new technology, skills and process changes need to be considered .

Technology adoption frameworks address the technological related determinants of the adoption and diffusion of innovations [7]. There are many researches attempted to provide comprehensive frameworks to identify significant factors that influence adoption of new technologies and innovations. The most used technology adoption models by researches are following frame works:. Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Unified Theory of Acceptance and use of Technology (UTAUT), Diffusion of Innovation (DOI), Technology-Organization-Environment(TOE) framework and Perceived e-readiness model (PERM) [12]. These models have differences in terms of their focus and are designed to examine different aspects of business technology adoption.[13] While DOI and TOE models focus organizational aspects, TAM, TPB and UTAUT models focus on individual aspects. This research is based on an organizational level and therefore, DOI and TOE models are reviewed.

2.2.1 DOI Model

Rogers 's DOI model is the most widely used and popular diffusion model.[14]. In this model there are five independent variables: Attribute of innovation, Type of innovation decision, Communication channels, Nature of social system and Extent of change agents' promotion efforts. Under the Perceived attributes of Innovations there are five attributes: Relative advantage, Compatibility, Complexity, Trial ability and Observerbility. According to DOI model, there are five stages, an individual or organization passes through during the adoption process: Knowledge of the innovation, Persuasion, Decision to reject or accept the innovation, Implementation of the innovation and Confirmation of the decision. The Rogers model of DOI is a comprehensive approach to analyse the diffusion of innovation, using two fields of psychology and sociology [14]. This model has been used for many fields like health care, education, and agriculture [14]. There are some criticisms also about the Rogers DOI model. This model is complex and overly broad and not focus on one specific field and therefore this model need to be modified depending on the discipline. J P.Lundbald [15], pointed out that Rogers model has not included inter-organizational factors and a lack of system related factors.

2.2.2 TOE Model

The TOE model consists of three factors which are related to the technology adoption namely, Technological context, Environment context and Organizational context. TOE model has been used in various empirical studies in variety of IT domains. Although TOE model has been used for many IT adoption studies, there are some criticisms about TOE model. J Dedrick et al. [16] describe TOE as only a classification model of variables and there is no integrated conceptual frame work. Further, they said that this is not a well developed theory.

2.3 Green Data Centres

Green IT concepts, technologies and practices can be applied to different areas in and organization. According to B Unhelkar [17], there are six main Green IT areas in the Green IT research field: End user devices, Servers, infrastructure, Communication equipments, Metrics and measurements and Risk management. More

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detailed classification for Green IT focus areas are given by S Murugesan [8]. Further, a comprehensive classification of Green IT is given by South Korean National information Society Agency (NIA) [18]. In this classification there are five major areas with sub sections: Data canters, Office environment, Procurement, Work practice, and Corporate citizenship. NIA classification is more specific to each and every aspect of the Green IT concepts.

3. RESEARCH METHODOLOGY

3.1 Conceptual Framework and Variables

There are two models related to technology adoption on organizational context, reviewed under the literature review: The Rogers' diffusion of innovation (DOI) model, and technology, organization and environment (TOE) model. There are several other studies related to technology adoption carried out using a combination of DOI model and TOE model Ex. [19], [20] and [21]. In DOI model Communication channels can be considered as an internal organizational factor, which is an essential part of any business, and need to be implemented internally. The Nature of social system in DOI model can be taken both as an environmental factor (External) and an organizational factor internally. The type of innovation is an external organizational factor. The perceived attribute of innovation is a technological related factor, because it highlights the properties of the technologies. The extent of change agent's promotion efforts can be taken as both internal and external factors. Hence, DOI model can be synthesized as TOE model. As discus in the literature review, the TOE framework is widely used in IT adoption studies. Therefore, the TOE model is used in this research, to develop the conceptual frame work for Green IT adoption of banking sector Data centres in Sri Lanka. According to the TOE model technological, Organizational (Internal) and Environmental factors (External) are considered for the conceptual frame work of the research. These three variables are the main independent variables and the green IT adoption is the dependent variable.

3.1.1 Technological Factors

According to F Thiesse [22] technological factors are the existing IT infrastructure and new technologies relevant to the organization. The main focus on this research is green IT adoption in data centres and therefore, the wide ranges of technological aspects related to data centre technologies are focused.

The following areas are investigated under the technological factors in data centres: Server virtualization, Sever optimal usage by power efficiency, implementing Storage Areas Network (SAN), Monitoring power consumption in data centres, and Design of data centres considering energy efficiencies.

Server virtualization is a green technology developed by IBM. Virtualization enables sharing resources between logical servers. Therefore, one server can be divided in to multiple logical servers and optimize the resource utilization by allocating hardware resources dynamically during the day and night time to optimize the utilization.

Server utilization can be optimized according to the power efficiency of the server. As an example, there may be old servers with less efficiency, but running critical applications in the banking data centre. These servers can be migrated to run less critical applications and powered down when the servers are not being utilized

Storage Area Network is a new technology which enables several servers to access capacity from a single storage. Individual servers in data centres utilize more power to rotate the hard disks inside the server. These hard disks may contain fewer quantities of data. Therefore this is a less efficient method. A SAN can handle several servers and allocate hard disk capacity on demand and enables optimal utilization of power consumption related to hard disks. This technology is included in the technology variable as a green initiative. Power consumption in a data centre can be monitored in real time in order to identify the variations, abnormal conditions and peak times. This is a very useful measurement use to take necessary action to optimize the power consumption. A proper data centre design optimizes the power consumption and floor space. A large data centre may be designed for future expansions. However, unused floor area too consumes additional power. Therefore, a regulated cooling system can optimize the energy consumption without compromising the data centre temperature control. In data centre design, an automated temperature control system can be used to efficiently control the temperature and humidity with optimized power consumption.

3.1.2 Organizational Factors

After reviewing the literature, following organizational factors are identified as relevant to the research: Communication level, Top management support, and Staff skills. Communication levels refer to the internal communication on importance of green IT concept throughout the organization. Top management support is a prerequisite for implementation of any new concept, because of the decision making power they wield. In addition, they have the power to take the financial decisions, including IT budgets. F Thiesse [22] believed that, management often takes better decisions related to sustainability. The adoption of Green IT can be a lengthy process and therefore, top management support is essential. The leaning and creativity are referred to as Staff skills [23].

3.1.3 Environmental Factors

After reviewing literature following environment factors are identified as related to this research; Competitive pressure, Customer pressure and Industry pressure. An organization may feel pressure from the competitors within the same industry. It may come from powerful companies in order to keep their image. Customer pressure is the ability of the customer to change

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the organization in order to satisfy the customer needs. Industry pressure is the trends in the similar industries and it forces organizations to change. The conceptual framework used for the research is shown in figure 1.

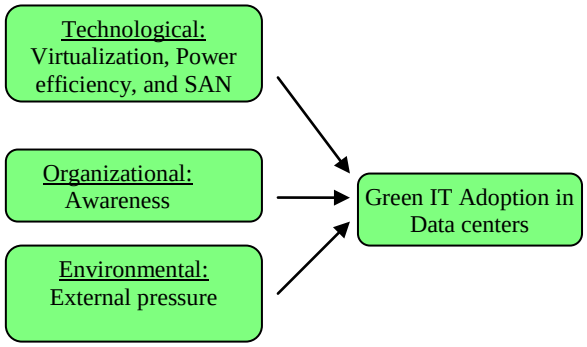

Fig 1: Conceptual frame work.

Based on above three factors following hypothesis were derived.

H_{1a}: There is a positive relationship between existing technologies and green IT adoption
H_{2a}: There is a positive relationship between organization factors and green IT adoption
H_{3a}: There is a positive relationship between external pressure and green IT adoption

3.2 Questionnaire and Data Collection

In order to test the above hypothesis, a questionnaire was designed. There are three independent variables and one dependent variable. Therefore, questionnaire is designed to cover all four variables. A five point likert scale is used to get the answers from the participants: Strongly disagree, Disagree, Neither agree nor Disagree, Agree and Strongly agree.

Initially a pilot test was carried out, on 10 participants from selected banks to find out any errors. Based on the comments made by 10 participants the questionnaire was finalized and sent to all participants. Google spared sheet is used to design the questionnaire and email to the participant with the link. A short description about the research and the benefit of the research is also mentioned in the email. After 2 days, 47 questionnaires were responded to and after 3 days another follow up email was sent to the participants. At the end 57 responses were received.

3.3 Population and Sampling

According to the Central Bank of Sri Lanka (2012), there are 24 licensed commercial banks in Sri Lanka. In this population, there are foreign banks operated in Sri Lanka and most of their data centres are located in other countries where the bank is head quartered. The total population of Lankan Banks is 13 and 4 banks were selected using random sampling method from the total population.

The employees in these banks were the targeted sample. The research is based on IT data centres and therefore employees and the managers, whose jobs are related to IT are only considered. The targeted participants of these banks are Data centre operators, Administrators, Network engineers, IT managers and CIO's (chief Information Officer). The organization structures of banks are different from each other. Therefore, the job roles and data centre involvements are different in each bank. In order to generalize the sample, employees in different levels and job categories are divided in to three main categories: IT operation staff, IT Managers and Top Management. According to the data given by the selected banks, the total number of IT staff in all four banks is 107. The Questionnaire was emailed to whole population of 107.

3.4 Data Analysis

After achieving the required amount of responses each and every response is checked for validity. Some respondents didn't reveal their occupation completely (Ex Banker). These data were also considered for the analysis but in some analysis these data not included. The collated data was directly exported to spread sheet from Google Drive. The Likert scale responses are then quantified from 1 to 5.

The data converted in the spread sheet is exported to PASW 18 (Formerly SPSS) for statistical analysis.

Reliability of the data is tested using Cronbach Alpha measurement. A value greater than 0.70 is considered as a reliable data set [21]. In this research data, the Cronbach alpha value is 0.938, which is higher than the acceptable level of 0.7.

3.4.1 Descriptive Analysis

Descriptive statistics transform raw data into a form that can provide informational factors. In this research, frequencies and percentages are calculated in order to get an idea about characteristics of different variables.

3.4.2 Spearman Correlation

According to G Lankaster [24], correlation methods are suitable for generation of empirical relationship to recognize the patterns between variables. Objective of this research is to identify the relationship between influential factors and Green IT adoption. Therefore, correlation methods are suitable for hypothesis testing. There are three widely used correlation methods.; Pearson correlation (r), Spearman rank (ρ) correlation and Kendll tau. Pearson correlation is used for parametric tests and variables need to be in normal distribution. But Spearman correlation can be used for non parametric tests. Further, Spearman rank correlation is used for ordinal scale data and Pearson correlation is more suitable for linear scale data. Kendell tau is not sensitive to large variations but Spearman correlation is better for large variations. Therefore Spearman rank correlation is used to test the hypothesis in this research.

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4. RESULTS

4.1 Descriptive Analysis

The highest percentage of responses was from managers and the lowest was the operations staff. Table 1 shows the number of responses and the response percentage. There is a clear difference in response rete between management level and non management level participants. Management and higher management response rate is more than 75% and it is 37.9% for non management staff. Table 2 shows the response rate form different banks. The response rate is between 41% and 77%

Table 1: Response rate of job categories

Job Category	Number of invitees	Number of responses	Response percentage
Manager	33	26	78.8
Operations staff	66	25	37.9
Top Management	8	6	75.0
Total	107	57	

Table 2: Response rate of banks

Name of Bank	Number of invitees	Number of responses	Response rate
A	39	18	46.1
B	21	15	71.4
C	34	14	41.2
D	13	10	76.9
Total	107	57	

Figure 2 shows the average responses for questions related to the independent variable "Technology". Highest average response was reported for the question 1 which is used to check the organisations policy related to server virtualisation. The least average response of 3.03 is recorded for the question 3 that asks about the organizations power usage monitoring systems. Moreover, significant difference can be seen between questions 6 which is on data centre rationalisation, and power consumption. Average response rate is more than 3.5 for questions 1, 2, 4 and 5 that focus on following areas: server virtualisation, server optimisation, energy efficient data centres, and temperature and moisture control of the data centres.

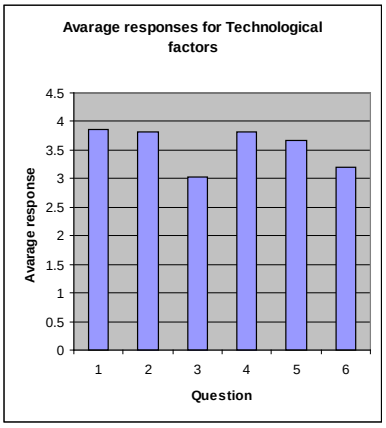

Fig 2: Average responses for questions related to the technological factors.

Figure 3 shows the average response for the questions related to employee awareness of Green IT initiative in the organisation. Participants' average response is lowest for the question 1, which is about Green IT education in the organisation. Commitment towards the Green initiatives of the Top executives (CEO, CFO and CIO) has the highest average response, which is greater than 3.5. Communication of organisation policies and vision, Current skills and knowledge of the employees and communication of Green IT results have recorded average response of 3.3 to 3.4. The overall average response of Awareness variable is 3.35, which is slightly higher than the response " Neither agree nor Disagree.

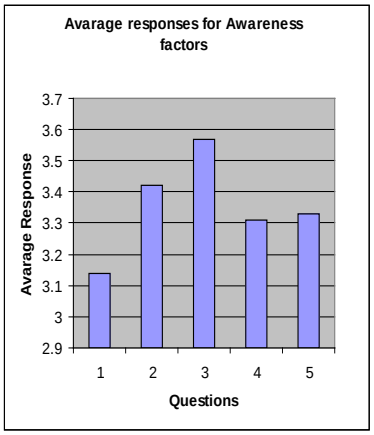

Fig 3: Average response for questions related to the awareness

There were six questions to measure the Independent variable "External pressure" and the average responses for each question are shown in figure 4. Among the participants, the highest average response of 3.98 was recorded for the question which examines the company image in the customer mind with Green initiatives. The next highest average response was received for question which measures the vitality of the competition in order to implement Green IT initiatives. The average response for the competitive pressure to invest in Green IT products is

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the lowest within the questions of this independent variable. The third question measures the demand for Green products and services among the organisations customers. The final question is on effectiveness of the quality and environment certificates in organisations position and, reputation and public image.

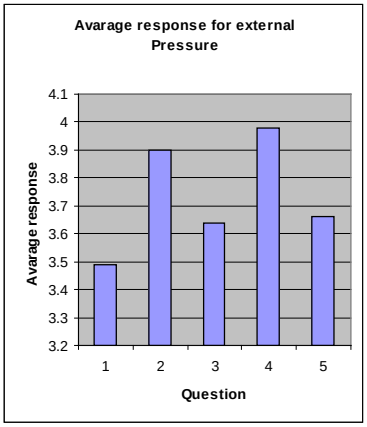

Fig 4: Average response for questions related to External pressure

Figure 5 shows the average response variation for the dependant variable Green IT adoption. The highest average response was 4.17 for question 4 which measures the organisations measurements to achieve Green IT goals such as reducing energy consumption. The lease average response recorded for the question 3, which checked the implementation of Green team to perform environment sustainability initiatives. Question 2 and 3 checked the organisation vision and the strategic sustainability plan respectively.

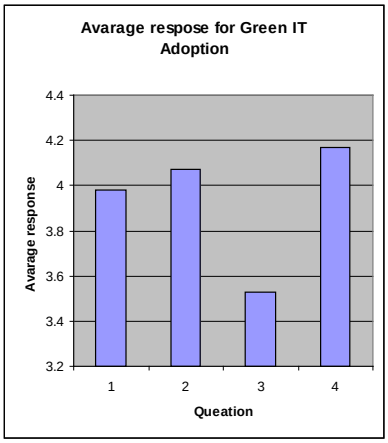

Fig.5: Average response for questions related to Green IT adoption

Although average values of the independent variables show the above results, there is a significant variation in responses for individual questions. Within the technological factors, one organisation is leading in the positive responses in virtualizations and server optimization based on power usage. All the participating banks were mostly uncertain about the following areas in technological factors: Real time power usage monitoring and data centre rationalization programs. One of the private sector bank and government own bank gave negative responses for the energy efficient data centre design and other two banks did not responded negatively. All participating banks were not given clear indication for automated temperature and moisture control of data centres. Most of the response for Green IT awareness questions were answered “Neither disagree nor agree”. Therefore, banks need to be focused on all the technological factors in order to achieve Green IT goals.

Green IT awareness of the top management was higher in one bank than the other 3 banks. Skills for green IT initiatives were higher at one of the government bank staff and obviously the bank has the highest response rate for Green IT education. These results shows that the participating banks need to initiate Green IT education for both staff and management.

The third impendent variable “External Pressure” has the more positive responses than other variables. Participants of one government bank and private sector bank believe that there are high demand for Green products and services such as internet banking, mobile banking and e-statements. All four participating banks agreed that Green initiatives strengthen the mind of customers. These results imply that, external pressure from the customers are high and all banks need to review their products and services, which can be transformed in to more greener than the existing products and services. New technologies with Green concepts are influencing more than other factors in this organizations. Therefore, employee awareness is also needed to be incorporated to achieve Green goals.

4.2 Hypothesis Test

Three Hypotheses are tested spearman rank correlation and according to the results given in the Table 3, all three hypotheses are accepted. First Hypothesis shows higher correlation than the other hypothesis with Spearman correlation with 0.847. The significant level is 0.000 mean that the correlation between Green IT adoption and the technological factors are strong.

The Green IT adoption and awareness are correlated with 0.787 (<0.8). The awareness is not very strongly correlated with Green IT adoption. But the significant level is 0.000. Therefore, Green awareness among employees and top management are correlated with Green IT adoption.

The Green IT adoption and the external pressure are correlated with 0.758(<0.8). This is not very strong correlation but the significant level is 0.000.Therefore, the external factors like customer pressure, competition and organization certifications are important influences for Green IT adoption.

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Table 3: Variation of spearman's rho

Independent variable	Speaman's rho	Significant level
Technology	0.847	0.0000
Awareness	0.787	0.0000
External Pressure	0.758	0.0000

5. CONCLUSIONS

The study was carried to explore the Green IT adoption in data centres of Sri Lankan Banks. Representative samples of 4 banks were selected in order to carry out the survey in a practical manner. The results show that there is a high positive relationship between Green IT adoption and the independent variables: Technological factors, Organizational factors and the External pressure.

The results indicate the highest correlation is between Green IT adoption and the technology related factors and the least correlation shows between external pressure and the Green IT adoption. Although there is no large difference between these two variables we can conclude that organizations are less pressurized on Green IT by competition than technologies.

The study was limited to data centres in Sri Lankan banks. Large scale data centres are also operated by telecommunication sector and manufacturing sector organizations. Hence, the research can be extended to other sectors. The adoption of Green IT also can be extended to other areas: Office environments, Procedures and policies and e- waste disposal.

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