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GREEN INFORMATION TECHNOLOGY METRICS FOR SUSTAINABILITY

Dr. Beenu Mago
Assistant Professor, School of Engineering and Information Technology, Al Dar University College Dubai, U.A.E.

ABSTRACT

Sustainability is the concern of all the organizations now-a-days. At the same time, no organization can survive without the use of technology. So there is a great need to integrate information technology and sustainability. This gives birth to the term Green Information Technology (GIT). This paper is an attempt to attempt to identify the metrics of green information technology for the sustainability of the organizations. Sustainability includes economic and environmental sustainability of the organizations. The researcher has used Molla's GITAM model as base model and extended it to identify the various metrics for sustainability of organizations. The researcher has identified Top Management support, Government support, Green IT Attitude, Green IT Policies, Green IT Practices, Green IT Technology as metrics that should be aligned with business processes to achieve the environmental and economic sustainability. The researcher contends in this paper that there is an earnest requirement for organizations to align those metrics with business processes to achieve sustainability. The results of this study help the organizations to make strategies related to green information technology for their economic and environmental sustainability. In this regard, this study fills the gap between the metrics of green information technology, its alignment with business processes and sustainability of organizations

Key words: Green Information Technology, Green Computing, Sustainable development, Green IT Adoption, Green IT Metrics.

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1. INTRODUCTION

In recent decades, sustainable development has emerged to become a hot issue for governments, societies, as well as businesses that ranging from underdeveloped, developing to developed countries. At the same time, Information Technology (IT) offers many advantages including expanded efficiency, easy access to data anywhere anytime. The survival of organization is nearly impossible without the involvement of information technology. Each organization, small or big, uses technology in one way or the other way. However, the production, use, and disposal of computers require huge amounts of energy and resources

and if not handled carefully, it can raise big issues for the environment and for the economic development of the organization also. But that doesn't mean to not to use technology. In fact, Information technology offers lot of prospects for organizations to maneuver in a greener manner and postulates an opening for its sustainable development. The idea is widely accepted by the organizations and by the government and flourished to the point where there is now general acceptance that green IT and green IS can be used to improve organizational performance – as an example the Gartner group has identified it as one of the top strategic technologies for a number of years [1,2]. This shows that the phenomenon of green IT is not only the concern of environmentalists and scientists and has gain the attraction of organizations to make a legitimate business strategy and to academicians [3, 4, 5].

Innovations are one of the main principles of a competitive advantage and they are important for the growth of organizations. A rapid development in the field of technology, consolidated with the globalization and fast changes in customer demand, indicates that a competitive advantage of a company can be only temporary [6]. Organizations put extraordinary effort in beating the competition and step-up in the market share by initiating innovations [6].On the macro level, the introduction of these innovations impact monetary improvement of a nation. Thus, it is not a surprise that innovations are more and more present in research, business and governmental circles both in developed and developing countries that wish to grow fast and become developed.

Therefore, Green IT enhances the sustainability of computing through manufacturing lower impact materials and products, reduced energy consumption of data centers and computers, and better recycling and end of life management. Formulation of appropriate policies and operations are requisite to react effectively and efficiently to the challenge of environmental sustainability, [7]. Therefore, IT is also expected to play a lead role in supporting a business's sustainability initiatives. Green IT has a capability to generate contemporary competitive opportunities, to diminish the production of carbon, and to recuperate overall business efficiency [8, 9]. As a result, the adoption of Green IT can be considered as a critical factor not only for the sustainability of businesses but also the success of the low carbon economy. While the opportunities and potentials of Green IT might be attractive, the extent of Green IT adoption and the actual realization of the benefits that Green IT aficionados allude to remain unknown. There is need to provide a comprehensive model that helps the organizations to identify the metrics of Green IT and to investigate how those metrics will be aligned with business processes to achieve sustainability. A model called as Green IT Adoption Model (GITAM) was proposed by Molla. The model defines Green IT from four distinct but interrelated perspectives. It posits that the technological, organizational and environmental contextual variables, dynamic Green IT readiness dimensions and strong order Green IT drivers can predict the intention and the breadth and depth of Green IT adoption. The purpose of this paper is to extend the breadth of GITAM model and to study its alignment with business processes to achieve sustainability in context of UAE.

The current study aims to address the following research questions.

1. What are the metrics of Green It?
2. How those metrics can be aligned with business processes.
3. How the above alignment will affect the sustainability of organizations.

The results of this study will assist in providing insights into the metrics of green IT and the results are significant for the stake holders, government and other academicians also.

2. LITERATURE REVIEW

As IT plays an integral role in almost all facets of businesses, and as each stage of the IT lifecycle from manufacturing to usage and disposal can pose environmental damages [10], it naturally follows that demands "environmental sustainability" should be extended to IT too. Organizations, governments, and societies at large have a new important agenda: tack-ling environmental issues and adopting environmentally sound practices. Over the years, the use of IT has exploded in several areas, improving

our lives and work and offering convenience along with several other benefits. However, IT has been contributing to environmental problems, which most people don't realize. Computers and other IT infrastructure consume significant amounts of electricity, placing a heavy burden on our electric grids and contributing to greenhouse gas emissions. Additionally, IT hardware poses severe environmental problems both during its production and its disposal. IT is a significant and growing part of the environmental problems we face today. We are obliged to minimize or eliminate where possible the environmental impact of IT to help create a more sustainable environment.

IT affects our environment in several different ways. Each stage of a computer's life, from its production, throughout its use, and into its disposal, presents environmental problems. Manufacturing computers and their various electronic and non-electronic components consumes electricity, raw materials, chemicals, and water, and generates hazardous waste. All these directly or indirectly increase carbon dioxide emissions and impact the environment. The total electrical energy consumption by servers, computers, monitors, data communications equipment, and cooling systems for data centers is steadily increasing. This increase in consumption of energy results in the increase of greenhouse gas emissions. Each PC in use generates about a ton of carbon dioxide every year

Green IT refers to environmentally sound IT. It's the study and practice of designing, manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment. Green IT also strives to achieve economic viability and improved system performance and use, while abiding by our social and ethical responsibilities. Thus, green IT includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of owner-ship, which includes the cost of disposal and recycling.

According to S Murugesan's [11] definition, there are three main areas to be focused, when studying, practicing, designing, manufacturing and using IT equipment. They are efficiency, effectiveness and minimal impact to the environment. S Murugesan's [11] definition is focused on the tangible IT hardware. This definition lacks organizational perspective. According to A. Molla et al. [11] Green IT is an ability of an organization to deploy environment sustainable criteria for IT infrastructure life cycle. O'Neil [13] defined Green IT as a reduction of carbon foot print within an organization by deploying initiatives which are desirable and strategic. According to S Mingay [14], Green IT is optimal usage of IT for environment sustainability within organizations operations. While the opportunities and potentials of Green IT might be attractive, the extent of Green IT adoption and the actual realization of the benefits that Green IT aficionados allude to be studied.

The literature indicates that Green IT can deal with the environmental and economical challenge to fulfill stakeholder's need. Much of the literature has provided practical examples on how organizations adopted green service practices and achieve better organizational performance.

According to World Commission on Environment and Development, "For the business enterprise, sustainable development means adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future." [17]. Green IT provides a socio-technical perspective on the diverse complex phenomena of organizational sustainability [18].

Molla [19] poses a new model (GITAM) relating to the adoption of green IT based on existing innovations and adoption models. According to Molla, Green IT context, Green IT Readiness and Green IT Drivers are the influencing factors for the organizations to adopt Green IT. The Green IT context includes - Technological context, Organizational context, and Environmental context. Green IT Readiness [18] captures a dynamic assessment of an organization's own and environment preparation to accept Green IT. Three drivers of Green IT can be identified: economical, regulatory and ethical [20]. In another research, Top management support is crucial factors of adoption and can be treated as companies' supportive attitude [21]. When the strategies endorse to set aside resources and guaranteed promise with a will, organizations are more willing to adopt Green IT. The above literature shows that different academicians

view point about sustainability and different factors for Green IT. The literature also shows that IT is always the integral part of organizations and sustainability is also crucial for the organizations. A Green Policy defines the approach your company is taking to improve the environment and provides a framework for the development of your green practices [24]. An improved financial bottom can be achieved by creating a green vision for your business and implementing projects and practices to achieve the vision [24]. The current study is identifies the following metrics based on literature review: Top Management Support, Government Support, Attitude towards Green IT, Green It Policies, and Green IT Practices. The researcher studies the impact of these metrics, when embedded with business processes, on environment and economic sustainability.

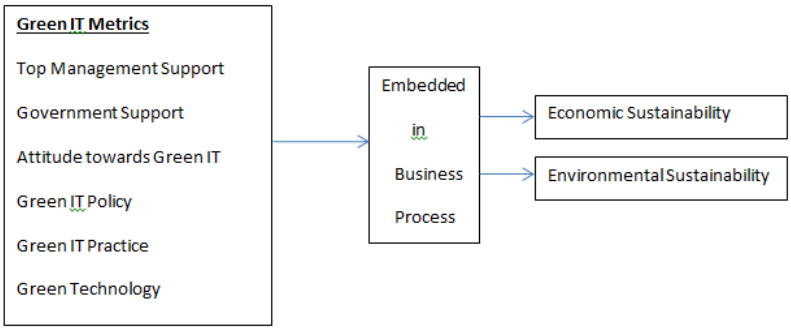

Figure 1 Conceptual Framework

Based on above framework, following hypothesis is formulated.

H1. Top management support in embedding green IT metrics in business process is positively related to economic sustainability of organization in UAE.

H2. Top management support in embedding green IT metrics in business process is positively related to environmental sustainability in UAE.

H3. Government support in embedding green IT metrics in business process is positively related to economic sustainability of organization in UAE.

H4. Government support in embedding green IT metrics in business process is positively related to environmental sustainability in UAE.

H5.Attitude towards Green IT embedded with business process is positively related to economic sustainability of organization in UAE.

H6.Attitude towards Green IT embedded with business process is positively related to environmental sustainability in UAE.

H7. Green IT policies embedded in business process are positively related to economic sustainability of organization in UAE.

H8. Green IT policies embedded in business process are positively related to environmental sustainability in UAE.

H9. Green IT practices embedded in business process are positively related to economic sustainability of organization in UAE.

H10. Green IT practices embedded in business process are positively related to environmental sustainability in UAE.

H11. Green technology embedded in business process is positively related to economic sustainability of organization in UAE.

H12. Green Technology embedded in business process is positively related to environmental sustainability in UAE.

3. RESEARCH METHODS

The structured scale was taken after extensive literature review. The green IT metrics section of the survey questionnaire was adapted from the existing instrument developed by Molla and Abareshi[20]. For the other sections of the model, the questions are taken from the scale developed by Houn-Gee Chen [22]. The questions are reworded as per the requirement of current study. The questions were structured using 5-point Likert scale which ranges from strongly agree 5, agree = 4, neutral= 3, disagree = 2 and strongly disagree = 1. Questionnaire was distributed to 150 respondents which were selected by convenience method of sampling in UAE. Out of these 150 questionnaires, 130 are considered as complete and retained for further data analysis. Others were discarded on account of incomplete information. The reliability of questionnaire is tested using Cronbach alpha test using SPSS 20 which was .754 which is highly acceptable as a rule of thumb [23].

4. ANALYSIS

Researchers used AMOS 20 to check the relationship between various variables. In this research, First measurement model is developed which is part of confirmatory factor analysis and then Structural equation modeling or path analysis is used to check the hypothesized relationship. Measurement model is used to check the relationship between observed variables and constructs.

4.1. Measurement Model

Measurement model defines the relationship between measured or observed variables and constructs or factors. In this model, all constructs are interdependent and treated as exogenous variables. After getting several models, researcher considered the following measurement model. The goodness-of-fit indices for this model are given below.

Table 1 Fit indices for Measurement Model

Model	Chi-Square	df	Normed Chi-Square	RMSEA	CFI
Measurement Model	203.732	124	1.827	.072	.903

The models have normed chi square of less than 3. RMSEA values are also less then maximum of 0.08 and CFI is greater than minimum required value of 0.90. In the current study, the researchers have used CFI as incremental fit index and chi-square, normed chi-square, Root Mean Square Error Approximation as used to test absolute fit index of data. This model is achieved by removing unacceptable items with low factor loadings usually less than equal to 0.5, preferably with factor loadings value is 0.70 and above.

Table 2 shows that the values of correlation coefficient between the various factors. The values shows there exists internal relationship between the variables also. The significance of the relationship is also checked. The results shown the there exists a significant correlation between Top Management Support, Government Support, Attitude towards Green IT, Green IT Policies, Green IT Practices, Green Technology and economic sustainability and environmental sustainabitity.

Table 2 Correlation

			Estimate
Top Management Support	<-->	Economic Sustainability	.815
Government Support	<-->		.716
Attitude towards Green IT	<-->		.807
Green IT Policy	<-->		.773
Green IT Practices	<-->		.797
Green Technology	<-->		.705
Top Management Support	<-->	Environmental Sustainability	.754
Government Support	<-->		.712
Attitude towards Green IT	<-->		.845
Green IT Policy	<-->		.678
Green IT Practices	<-->		.844
Green Technology	<-->		.817

Table 3 Fit indices for Structured Model

Model	Chi-Square	df	Normed Chi-Square	RMSEA	CFI
Structured Model	223.812	124	1.929	.071	.878

The above table shows that the structured model has absolute indices (Normed chi-square and RMSEA) are less than 0.3 and increment indices is greater than 0.9 which confirms the goodness-of-fit of the model. The statistics are same as those of the best fit measurement model used for structural model.

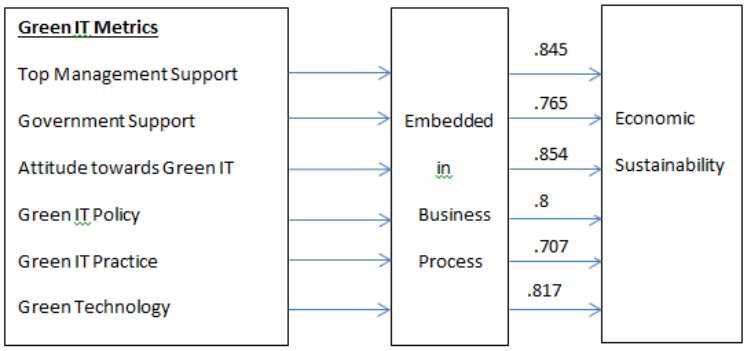

Figure 2(a) Structural Model

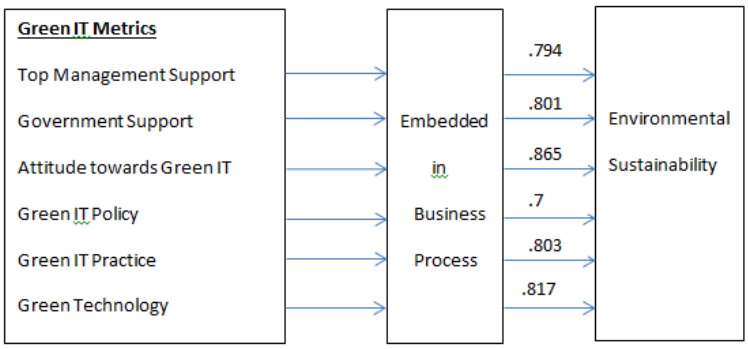

Figure 2(b) Structural Model

The test of the structural model includes estimating the path coefficients, which indicate the strengths of the relationships between the independent and dependent variables. The overall results of the analysis are shown in Figure 2(a) and 2(b). The significance level is 95%. Path coefficients are used to test the hypothesized relationships between dependent and independent variables. Accordingly, following hypothesis are accepted

H1. Top management support (path coefficient =.845) in embedding green IT metrics in business process is positively related to economic sustainability of organization in UAE.

H2. Top management support (path coefficient =.794) in embedding green IT metrics in business process is positively related to environmental sustainability in UAE.

H3. Government support (path coefficient =.765) in embedding green IT metrics in business process is positively related to economic sustainability of organization in UAE.

H4. Government support (path coefficient =.801) in embedding green IT metrics in business process is positively related to environmental sustainability in UAE.

H5.Attitude towards Green IT (path coefficient =.854) embedded with business process is positively related to economic sustainability of organization in UAE.

H6.Attitude towards Green IT (path coefficient =.865) embedded with business process is positively related to environmental sustainability in UAE.

H7. Green IT policies (path coefficient =.8) embedded in business process are positively related to economic sustainability of organization in UAE.

H8. Green IT policies (path coefficient =.7) embedded in business process are positively related to environmental sustainability in UAE.

H9. Green IT practices (path coefficient =.707) embedded in business process are positively related to economic sustainability of organization in UAE.

H10. Green IT practices (path coefficient =.803) embedded in business process are positively related to environmental sustainability in UAE.

H11. Green technology (path coefficient =.725) embedded in business process is positively related to economic sustainability of organization in UAE.

H12. Green Technology (path coefficient =.817) embedded in business process is positively related to environmental sustainability in UAE.

5. DISCUSSION AND CONCLUSION

The results of the study will contribute to the metrics of Green IT which when embedded in business process in the organizations in UAE lead to economic and environmental sustainability. The study identified those metrics from literature review. The results indicate that Top Management Support is required to embed Green IT in the Business Processes to achieve economic and environmental sustainability but the impact is more in case of economic sustainability. The path coefficients also show that significance and relative importance of metrics for economic stability in the following order: the Attitude towards Green IT, Top Management Support, Green IT Policy, Government Support, Green Technology and Green Practices. However, Environmental supportability is also impacted mostly by Attitude, followed by Green Technology and Government Support and finally followed by other metrics. The findings are useful for researchers and academicians also as this study provide the grounds to explore the metrics of Green IT in detail in UAE. The results of the study are significant for the policy makers in

organizations and to the government of UAE as the government support is very important to force the organizations to implement Green IT.

This study is not without limitations. The results of the study can't be generalized as the study is conducted only in UAE. Secondly, the findings need to be confirmed with large sample size. Thirdly, the future research is required to check the internal impact of each metrics of Green IT on each of it.

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