Environmental Intelligence and its Impact on Collaborative Business

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Abstract - Green IT can be defined as the conscious implementation of technologies, techniques and policies designed to reduce the carbon footprint of the IT function within the organization and the use of IT to reduce the carbon footprint of the whole organization. By adopting Green IT practices, business enterprises can contribute positively to environmental stewardship and protect the environment while reducing the energy costs. The holistic approach to environmental sustainability making the best use of IT resources available to the organization is termed as environmental intelligence (EI) in this paper.

This paper explores creative ways of looking at the environmental challenge, opens up opportunities to examine processes for collaboration, take stock of the inventory and infrastructure for optimization, and explore the possibilities of new business streams. This research paper aims to find out the impact of technologies such as server virtualization, cloud computing, anytime anywhere technologies and right network (as a specialist domain of Green ICT) on EI of different business organizations of Vadodara. This study employed the ordinal logistic regression to understand the impact of green ICT on the manufacturing business.

Index Terms - Green IT, Environmentally Sustainable, Environmental Intelligence (EI), Server Virtualization, Cloud Computing

1. INTRODUCTION

A sensible and carefully created environmental strategy will not only handle the immediate environmental impact but will also include carbon performance as a part of its risk management approach. The environmentally conscious practices of an organization are not restricted to its IT equipments and process; instead this becomes an all-encompassing adventure by its organization that also includes the consideration for emerging ICT in the business processes and policies [1]. Green IT is studied from two angles: reducing the emissions from IT use in business and using IT to reduce the carbon footprints of an organization. The primary value of Green IT is derived through environmental performance improvement in all sectors of an organization by using IT products and technologies.

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The Green IT thus also creates profitable opportunities for business by enabling design and deployment of IT-based solutions that create a low carbon economy [2]. The IT industry has, of late, extended the scope of Green IT to include the manner in which IT is deployed to help reduce GHG emissions, to introduce energy efficiencies, or to reduce energy consumption [3] [4].

This research paper studies the impact of environmental Intelligence (EI) for Green ICT on the collaborative business ecosystem of Vadodara. Vadodara is the third most populated city in the Indian state of Gujarat. In line with the 'Knowledge City' vision of the confederation of Indian Industry, Vadodara is gradually becoming a hub in Gujarat for IT and other development projects. A survey was conducted using cross sectional approach. The research population consist of all the business units of Vadodara which are hugely using IT and IT infrastructure in the organization.

This research has explored the current application of Green ICT as well as the readiness for Green ICT in an organization. The research gave a new insight to EI, by explaining EI as a practical approach bringing together the tools and techniques of Green ICT to achieve the dual purpose of business and environmental efficiency. This research has investigated the impact of EI on the different business categories.

2. LITERATURE REVIEW

Green ICT is concerned with both the viability of the organization and its efficient operations [5]. Osborne [6] stated that attainment of Green IT is that optimum balance between minimizing the responsibility for carbon emissions while delivering the optimum IT function to support the enterprise. This cannot be zero; the equipment life cycle will generate an impact, but steps can be taken to minimize the impacts. The IT sector has a profitable opportunity and a critical role to play with other sectors to design and deploy solutions needed to create a low carbon society [7]. This research explores the depth of environmental challenges in the current business setup through emerging ICT. Right network, Anytime anywhere technologies, server virtualization and cloud computing are the technologies which has the ability to reduce an organization's carbon footprint by facilitating more efficient and less carbon intensive work practices such as teleconferencing instead of flying or commuting [8].

Green IT is expected to improve both environmental and economic challenges. The emerging technologies of IT focus on the opportunities and have the ability to transform the current business model to EI business. Cloud computing has emerged as the natural evolution and integration of advances in several fields including utility computing, distributed

computing, grid computing, web services, and service oriented architecture [9]; providing substantial opportunities for organizations to consolidate their hardware and corresponding data space requirements [10] . This is a whole new form of computing and is allowing thousands of users from all around the world to access something without having to download and install anything on their own computers.

Mobility enables virtual collaboration between business and individuals. Reengineering the business processes with mobility provides enormous opportunities for virtualization. The more virtual a business is the less physical resources it will consume—therefore, well-modeled mobile processes greatly assist in creation of environment friendly businesses. Mobility has the potential to further enhance the data sharing among the business application. This is so because mobility enables location independent data sharing. Mobility reduces access time, optimizes input of data, and offers location-based insights. The mobile devices have the capability to connect to the global network while they are connected to individual people, regardless of their location and time. Mobility is a significant factor in the quality of life of individuals and society as a whole [11].

The ICT technologies discussed above can be applied to the following business purposes, in order to drive environmental intelligence (EI); Reduction of energy consumption, reduction of carbon footprints, reduction of the operational costs are the important goals defined by organizations to adopt green practices and policies for the Green ICT.

3. RESEARCH MODEL AND HYPOTHESIS DEVELOPMENT

Based on previous studies a questionnaire was developed to understand the impact of Green IT on the environmental goals of the business. The first section of the questionnaire consisted of items such as name of the organization, number of computers and peripherals, information about computer networking. The second section included the Green ICT factors: Right Network (RN), Anytime Anywhere Technologies (ATAW), Server Virtualization (SV), and Cloud Computing (CC) influencing the environmental goals of a business. The third section included variables which measure the dependent variable. Impact is identified by reduction of energy consumption, reduction of carbon footprints and reduction of operational cost [12]. Finally all the three variables summarize into a single variable, which is a dependent variable (DV) called 'Impact of Environmental Intelligence' of a business from expert's viewpoint [26]. Independent variables can be categorized into four factors which are detailed along with the hypothesis in Table 1.

The hypothesis in Table 1 are detailed as -

H1: There is a significant impact of use of EI for RN in collaborative business.

H2: There is a significant impact of use of EI for ATAW in collaborative business.

H3: There is a significant impact of use of EI for SV in collaborative business.

H4: There is a significant impact of use of EI for CC in collaborative business.

Factors	Items	Hypothesis
RN	Global network protocol , Network can be easily scalable to support growth , Supports collaborations and mobile technologies , Supports effective supply, production and distribution processes centralization and better performance of line-of-business applications ,Supports effective ecommerce , Handles all voice, data and multimedia traffic and applications on one network eliminating duplication of bandwidth, networking equipment and network management resources	H1
ATAW	Minimize the need to travel at all via remote working and video conferencing to reduce congestion and vehicle emission, Make presentations to customers, and being able to download product information to their network during the visit, Quote business quotations and interactive order processing , Check stock levels via the office network , Interact with colleagues while travelling - sending and receiving emails, collaborating on responses to tenders, delivering trip reports in a timely manner.	H2
SV	Reduce hardware peripherals, Share applications instances between multiple organizations, Improve time-to-market of new applications , Better sharing infrastructure investments across groups, Operational system efficiency and simplified management due to better use of infrastructure ,Be more responsive to the needs of the business ,Improve business continuity and disaster recovery ,Speed up deployment of new applications	H3
CC	Data Duplication , Access control , Innovation , Outsourcing , Tele-working , Efficient data handling, Increase technical capability	H4

Table 1: Independent Variables (IV) and Research Hypothesis

4. METHODOLOGY

The research subject "to investigate the impact of use of EI for Green IT practices on an organization" predetermines the choice of statistical test and analysis to be used in the study.

389 business enterprises constitute the population; the population is divided into 8 strata. If N is the size of the population, n is the size of the sample and i represents 1,2,…k [number of strata in the population], then proportionate stratified sampling is defined as

p = n1/N1 = n2/N2 = …n8/N8 =n/N,

p = 70% is the proportion selected from each strata in the population in this research (as shown in Table 2). The stratum are manufacturing units (S1), Schools (S2), Colleges(S3), Hospitals (S4), Banks, Finance and Insurance (S5), Retail and Shopping Malls(S6), Administrative and Support services (S7) and Computer training and Software development centers (S8).

Stratum No.	Stratum population	Stratum Sample selected (70%)	Sample Response
S1	73	51	50
S2	65	45	40
S3	32	23	20
S4	37	26	22
S5	42	29	21
S6	40	28	21
S7	44	30	19
S8	54	37	32

Table 2: Stratum Population and Stratum Sample

A 5–point likert scale ranging from 1 as strongly disagrees to 5 as strongly agree was used for the measurement. A test for the reliability of the instrument was conducted for each stratum population. The internal consistency is checked using cronbach's alpha coefficient and is tabulated in Table 3.

Stratum	RN	ATAW	SV	CC
S1	0.8324	0.7255	0.7045	0.6982
S2	0.7711	0.7232	0.8722	0.8223
S3	0.8712	0.7342	0.7611	0.7433
S4	0.8732	0.8732	0.8345	0.7764
S5	0.7834	0.8876	0.8342	0.7943
S6	0.7223	0.8811	*0.4672*	*0.3588*
S7	0.7056	0.7232	0.7722	0.7223
S8	0.8722	0.8762	0.7722	0.8743

Table 3: Reliability Test

This research employed the ordinal logistic regression to drive its results. An ordinal logistic regression is used to handle multiple ordinal dependent variables. Minitab 14 is a statistical software package that can fit an ordinal logistic regression to data. The output of the software includes: 1) Response and Factor Information, which displays the number of observations and the response and factor categories; 2) Logistic Regression Table, which shows the estimated coefficients (C), p-values (P) (related to a test that the corresponding coefficient is zero) and odds ratio (O) (which shows the effect of variables on the model); 3) Goodness-of-Fit Tests which displays both Pearson goodness-of-fit test of the model to data. Final and appropriate model is chosen by entering variables which their coefficients are significant (p-value<0.05) and ordering effect of variables from their odds ratio negative coefficient along smallest odds ratio indicates more impact of the variable on the dependent variable [13]. Finally, appropriative of model is evaluated by (i) a G test whose null hypothesis states all the coefficients associated with predictors equal zero versus at least one coefficient is not zero (we prefer to reject their null hypothesis, i.e., p-value <0.05) and (ii) Goodness-of-Fit Tests, (we prefer to accept their null hypothesis, i.e., p-value >0.05), of which more can be found [13]. The equation of ordinal logistic regression in this research model are given below.

$$\gamma_i = \frac{\exp(\alpha i + \text{coeff}(RN) + \text{coeff}(ATAW) + \text{coeff}(SV) + \text{coeff}(CC))}{1 + \exp(\alpha i + \text{coeff}(RN) + \text{coeff}(ATAW) + \text{coeff}(SV) + \text{coeff}(CC))}$$

where i= (1,2,3,4)

γ_i is the cumulative probability efficiency of the EI of i^{th} level , $\underline{\alpha_i}$ are the coefficients for each level.

5. RESULTS

The impact of environmentally responsible business strategies in the businesses are tabulated in Table 4 to Table 7. The odds that an event occurs is the ratio of the number of people who experience the event to the number of people who do not. This is what one get when one divide the probability that the event occurs by the probability that the event does not occur, since both probabilities have the same denominator and it cancels, leaving the number of events divided by the number of non-events. The coefficients in the logistic regression model tell how much the logic changes based on the values of the predictor variables.

5.1 EI and its impact on reduction of energy consumption in business

Table 4 shows the results of the Ordinal Logistic Regression for the impact of EI on reduction of energy consumption in all the strata.

		RN	ATAW	SV	CC
S1	C	-0.351	-0.332	-0.772	-1.67
	P	0.046	0.003	0.016	0.028
	O	0.69	0.28	0.55	0.67
	R	4	1	2	3
S2	C	-0.887	-1.876	-0.781	-0.771
	P	0.001	0.089	0.004	0.453
	O	0.43	1.65	0.87	0.66
	R	1	-	2	-
S3	C	-0.112	-1.665	-2.555	-0.0112
	P	0.022	0.000	0.000	0.016
	O	0.71	0.56	0.62	0.67
	R	4	1	2	3
S4	C	-0.228	-0.778	-1.778	-1.778

		RN	ATAW	SV	CC
	P	0.032	0.214	0.074	0.397
	O	0.24	1.22	0.77	0.76
	R	1	-	-	-
S5	C	-0.213	-1.778	-0.671	-2.562
	P	0.046	0.003	0.009	0.006
	O	0.41	0.28	0.38	0.32
	R	4	1	3	2
S6	C	-0.223	-0.343	-	-
	P	0.018	0.003	-	-
	O	0.66	0.32	-	-
	R	2	1	-	-
S7	C	-0.786	-0.771	-0.771	-2.881
	P	0.036	0.003	0.012	0.028
	O	0.67	0.22	0.39	0.51
	R	4	1	2	3
S8	C	-0.662	-1.661	-0.191	-0.881
	P	0.046	0.003	0.016	0.028
	O	1.92	0.67	1.87	1.89
	R	4	1	2	3

Table 4: EI and its impact on Reduction of Energy Consumption in Business

Results in Table 4 summarizes that p-value (>0.05) indicates that businesses are not adopting such practices and hence they do not contribute to the reduction of energy consumption. A comparative study of collaborative businesses shows that stratum 2, stratum 4 and stratum 6 has least awareness regarding use of emerging ICT & has insignificant impact on the energy consumption of the business. The negative coefficients and the p-values (<0.05) for the choice of right network indicates that right network practices are related to lower the energy consumption of the business.

5.2 EI and its impact on reduction of carbon footprints in business

Table 5 shows the impact on EI on the reduction of carbon footprints of a business organization.

		RN	ATAW	SV	CC
S1	C	0.291	-0.561	-0.721	0.82
	P	0.649	0.002	0.018	0.16
	O	0.67	0.29	1.1	1.7
	R	-	1	2	-
S2	C	0.657	0.897	0.887	0.11
	P	0.339	0.074	0.148	0.16
	O	0.99	0.89	0.98	0.87
	R	-	-	-	-
S3	C	1887	-1.65	-1.9	-0.886
	P	0.546	0.001	0.009	0.028
	O	1.9	0.37	0.66	0.98
	R	-	1	2	3
S4	C	0.912	0.877	4.2	1.98
	P	0.395	0.074	0.397	0.134
	O	1.76	1.98	0.88	0.56
	R	-	-	-	-
S5	C	-0.871	-1.769	0.887	129
	P	0.003	0.002	0.214	0.047
	O	1.65	0.54	1.92	1.71
	R	2	1	-	3
S6	C	0.881	-2.109	-	-
	P	0.649	0.002	-	-
	O	0.76	0.76	-	-
	R	-	1	-	-
S7	C	4.76	1.223	-0.564	0.871
	P	0.623	0.392	0.014	0.187
	O	0.88	0.39	0.38	0.66
	R	-	-	1	-
S8	C	-0.619	-0.672	-0.781	-0.261
	P	0.016	0.002	0.018	0.002
	O	2.1	1.01	2.9	1.23
	R	3	1	4	2

Table 5: EI and its impact on reduction of carbon footprints in business

Results in Table 5 can be summarized as most businesses are not well conversant with carbon reduction and carbon footprints from the use of ICT. Reduction of carbon emissions is not a strong motivational factor in businesses to adopt EI.

5.3 EI and its impact on reduction of operational cost in business

Table 6 comprehensively illustrates the impact of EI on the reduction of operational cost in business.

		RN	ATAW	SV	CC
S1	C	-1.262	0.810	1.887	0.87
	P	0.018	0.075	0.166	0.075
	O	0.72	0.77	0.77	0.77
	R	1	-	-	-
S2	C	0.8978	0.291	0.828	-0.675
	P	0.318	0.075	0.117	0.017
	O	2.1	1.8	0.89	0.38
	R	-	-	-	1
S3	C	-0.651	-0.78	-1.818	-0.672
	P	0.018	0.032	0.005	0.012
	O	1.89	2.05	0.78	1.1
	R	3	4	1	2
S4	C	0.261	0.2611	0.191	0.987
	P	0.649	0.075	0.166	0.214
	O	0.78	0.87	0.27	0.76
	R	-	-	-	-
S5	C	-1.8	-0.272	-1.191	-0.538
	P	0.018	0.003	0.018	0.001
	O	1.1	0.78	1.5	0.61
	R	3	2	4	1
S6	C	-0.87	0.819	-	-
	P	0.006	0.075	-	-

		RN	ATAW	SV	CC
	O	0.69	1.4	-	-
	R	1	-	-	-
S7	C	-2.001	1.982	0.672	1.89
	P	0.018	0.075	0.107	0.075
	O	0.41	0.76	0.78	0.82
	R	1	-	-	-
S8	C	-0.502	-0.366	-0.464	-0.119
	P	0.018	0.002	0.002	0.009
	O	0.74	0.29	0.36	0.51
	R	4	1	2	3

Table 6: EI and its impact on reduction of operational cost in business

The reduction of operational cost is highlighted as one of the important motivation for reducing energy efficient ICT. The results in Table 6 shows that the use of emerging ICT such as ATAW technologies, CC are correlated to the reduction of operational cost such as reduction of paper and travelling.

5.4 EI and its impact on the collaborative business

All the variables are ordinal; a median is employed to summarize a group of items into one single variable. They all grouped in one variable called Impact. Table 7 summarizes EI and its impact on collaborative business.

		RN	ATAW	SV	CC
S1	C	*	-1.54	*	*
	P	0.102	0.006	0.429	0.28
	O	*	0.37	*	*
	R	*	1	*	*
S2	C	-1.743	*	*	-0.629
	P	0.013	0.156	0.071	0.016
	O	0.69	*	*	0.78
	R	1	*	*	2
S3	C	-0.321	-0.719	-2.161	-0.811
	P	0.005	0.003	0.021	0.025
	O	0.38	0.29	1.39	1.42
	R	2	1	3	4
S4	C	*	*	*	*
	P	0.072	0.56	0.167	0.181
	O	*	*	*	*
	R	*	*	*	*
S5	C	-2.814	-2.371	*	-0.562
	P	0.005	0.002	0.721	0.037
	O	0.37	0.29	*	1.15
	R	2	1	*	
S6	C	-0.924	*	*	*
	P	0.032	0.281	0.551	0.072
	O	2.01	*	*	*
	R	1	*	*	*
S7	C	-0.945	*	*	*
	P	0.015	0.62	0.81	0.055
	O	0.82	*	*	*
	R	1	*	*	*
S8	C	-2.12	-0.453	-0.591	-0.671

		RN	ATAW	SV	CC
	P	0.014	0.002	0.016	0.003
	O	1.15	0.67	1.18	0.72
	R	3	1	4	2

Table 7: EI and its impact on the collaborative Business

If the p-value is less than the alpha-level (0.05), the test rejects the null hypothesis that the model does not fit the data adequately and accepts the hypothesis. In Table 8 √ represents that the hypothesis is accepted and × represents that the hypothesis is rejected. The hypothesis is tested stratum wise.

	H1	H2	H3	H4
S1	×	√	×	×
S2	√	×	×	√
S3	√	√	√	√
S4	×	×	×	×
S5	√	√	×	√
S6	√	×	×	×
S7	√	×	×	×
S8	√	√	√	√

Table 8: EI and its impact on Collaborative Business

6. CONCLUSION

The study suggests that Environmental Intelligence for greening of ICT and its application is less explored in Vadodara region, the business sections covering hospitals and retail shopping malls are not considering any significant impact of greening of ICT in their business. Right network and anytime any where technologies have more impact on the businesses. Motivational factors are the reduction of energy consumption and reduction of operational cost.

The results tabulated and analyzed in Section 5.0 depicts that Environmental Intelligence (EI) in computing represents a responsible way to address the issue of energy consumption and operational cost in a business enterprise. By adopting EI practices, business leaders can contribute positively to environmental stewardship and reduce environmental footprints while reducing energy and operational cost.

Based on the results, it can be recommended that strategic alignment of new and emerging ICT technologies such as mobile technology, cloud computing, virtualization with business has been a key in delivering competitive advantage to business, especially in stratum 1(manufacturing units), stratum 3 (Colleges), stratum 5 (Banks, Finance & insurance companies)and stratum 8 (Computer Training & Software Development Centers). This alignment needs to be kept in mind when it comes to innovative use of emerging technologies and carbon reduction.

The technologies that are most likely to have an impact on collaborative business are right network and mobile technologies. The results in Section 5.0 illustrate that cloud computing is now becoming an important part of an organization's business approach, but they also require a corresponding business model that can support the use of these technologies.

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