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Sustainable Computing in Oman: A Corporate Social Responsibility Where Cost-Cutting and Environmental Concerns Take a Backseat

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This paper primarily focuses on examining the level of awareness about sustainable computing amongst the participants and to further explore, if there are any visible measures taken or the policies implemented for the same in selected academic organisations in Oman. In addition, the knowledge about sustainable computing is monitored, assessed and supported through a single group pre-test and post-test research design to establish the relevance of the intervention study though inferential statistical analysis. The research examines the alarming rate of ignorance towards sustainable computing amongst the participants. Consequently, creating an evident necessity for increased level of awareness and knowledge through constant training and support. Therefore, an intervention experiment was conducted through a pre-test and post-test research design, where the same set of participants were exposed to a self-instructional module with the intention of observing increased level of knowledge.

JEL Codes: M14, O13, O32, O33, Q20 and Q29

1. Introduction

Sustainable computing is not just a single term but it encompasses many principles and practices along with the procedures and attitudes that define and governs the whole organisation in terms of the usage of Information Technology (IT). It is a holistic approach that stretches from power to waste to purchasing to education and is a life-cycle management approach to the deployment of IT across an organization. Elliot (2007) has defined Sustainable Computing as "The design, production, operation, and disposal of ICT and ICT-enabled products and services in a manner that is not harmful, and is positively beneficial to the environment during the course of its whole-of-life." The concept of Sustainable Computing considers the total cost of ownership, the total impact, and the total benefit of technology systems (Cornell University 2005). Green IT can also be defined in terms of the careful practices involved in implementing the sustainable computing in a way that it minimises energy consumption and leaves the least impact on the environment. In addition, the concept of Green IT confirms to the definition from the Brundtland commission, which states that sustainability is all about meeting the present needs of the business without disturbing the ecological system for the future generations (WCED 1987).

Nowadays, data centres and the corporate sector are considering sustainable computing as a major area of concern and are conducting explorative studies to implement Green IT for measuring the success not only in terms of profit but also in terms of social responsibility. At the same time, usage of IT is not restricted only to the big data centres but also to comparatively smaller organisations. The role of IT in higher education is vital and that

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makes all academic organisations to some extent heavy users of computers. This prompts to throw some light on the fact, whether the academic organisations in Oman are lacking theoretical and practical knowledge of the concepts of sustainable computing or not. Therefore, the research was conducted among the employees of various academic organisations through a single group pretest - posttest research design to assess the existing subject knowledge and to explore the necessity of an intervention study. Samples were selected using non probability sampling technique and their knowledge on sustainable computing was tested using a structured questionnaire. The respondents were later exposed to a Self-Instruction Module (SIM) about sustainable computing in order to achieve increased level of knowledge.

Presently, sustainable computing is perhaps the main area of concern for a large number of researchers and organisations across the world. However, this is pertinent that when many developed and developing countries are taking up this issue with much sincerity as their corporate social responsibility for environment protection and cost reduction; the initiatives in terms of implementing procedures and practices are not quite visible in a Gulf country like Oman. The awareness is limited, nonetheless, the possibilities of explorative research are unlimited. Based on the success of this research, tremendous opportunity to conduct further explorative study and research can be identified to adopt and implement the practices of sustainable computing as a corporate social responsibility, and to develop a more practical nation-wide framework for academic organisations as well as for the other organisations such as banks and SMEs (small and medium size enterprises) in Oman.

The objective of the research is to assess the existing level of awareness and to carefully examine the effect of an intervention experiment on the existing level of knowledge. The paper is divided into five sections. The First section provides a brief overview of the topic and the research, the second section presents an intensive literature review, the third section defines the methodology, the fourth section discusses data analysis and findings and finally, conclusions are drawn in the last section.

2. Literature Review

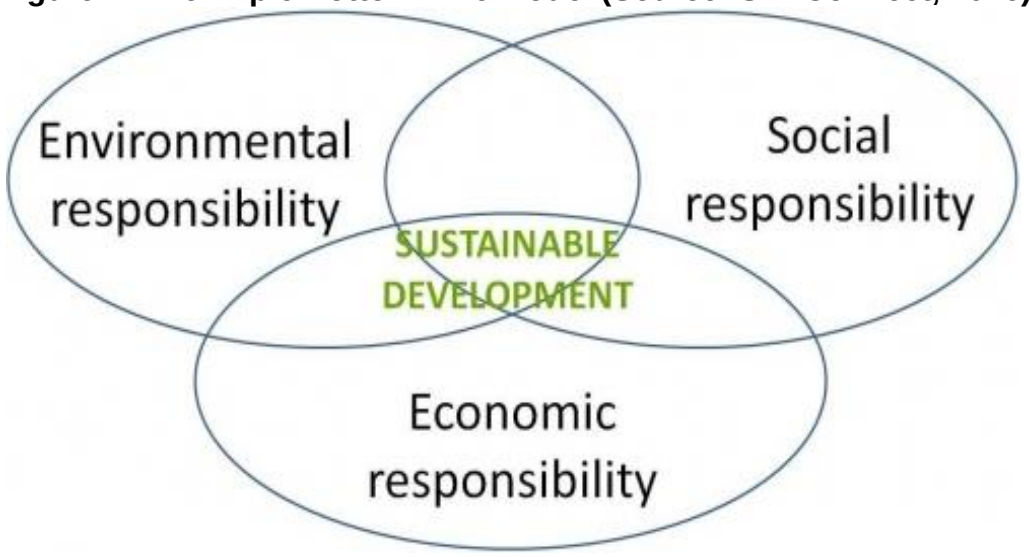
As per the Green IT Global report (2009), a survey was conducted in 429 North American and 1052 worldwide companies to assess the requirements of sustainable computing, and the survey results clearly exhibited the need of implementing the sustainable initiatives for Green IT, as 86% of the respondents believed and said the same. However, even after the majority in consensus agreed to the fact that the requirement of developing a sustainable plan is imperative, there is still a lot of scope for research and development in devising and practicing an effective strategy toward achieving the acceptable sustainability standards in the said field of computing. The same report further stated that 97% of the surveyed companies were in agreement to adopt a sustainable computing strategy, whereas, 57% of them have already started trying out the strategies planned and among those, 45% have successfully implemented the required policies and procedures. In addition, 90% of the companies showed the willingness to spend a significant amount of money on energy efficient hardware. Therefore, at this point, it is important to ponder upon the major research questions and the areas where the exploratory study is required. As very precisely proposed by Brookes et al. (2010), the major areas of study are; the strategy for adopting Green IT practices within an organisation and the recent manifold increase in the adoption of Green IT techniques in Information Systems and other aspects on the organisations. Moreover, further research is suggested to encourage the organisations to initiate and bring sustainable computing as a corporate social responsibility (CRS). This was further confirmed

by the Green IT Global report (2009), which stated that majority of the companies were not only aiming at cost cutting while developing the policies and procedures for sustainable computing but they were relatively more inclined towards the realisation of their CSR.

Strong environmental sustainability states that the waste emission rates must not exceed the environment's waste assimilation rates; the consumption rate of renewable resources must not exceed the environment's regeneration rates, and the depletion rate of non-renewables must not exceed the development rates for renewable substitutes (Howard & Lubbe 2013). CSR is to monitor the impact of the business on the people, community and environment. However, this basic understanding is often forgotten by most of the organisations and no serious measures or strategies are observed towards fulfilling this responsibility, especially in the Middle Eastern region where environmental concerns often take a backseat due to lack of awareness and lesser economic constraints. Nowadays, when many well established universities are declaring their campuses as green; most educational organisations in Oman are still unaware of the magnitude of the problem and are not considering the power and the energy as critical factors while designing their IT systems.

As stated in an article from the University of Wisconsin (2016), the times have come where the success of a business is not defined only by monitory profits but it is more evidently seen as a balanced mix of three major aspects in terms of building communities, being sensitive towards the environment and economic growth. However, it is difficult to measure sustainability in terms of its effect on the society and environment, but at the same time, it is important; as what is measured, is monitored. To assess sustainability in an organisation, "the triple bottom line" model (TBL) was developed and proposed by John Elkington in 1994, which was based on the idea of defining three bottom lines in every organisation. The three bottom lines are also known as three Ps as they refer to the bottom line of the profit and loss account, bottom line of people account and bottom line of the company's planet account (The Economist 2016). TBL can be perceived as a possible solution to assess sustainability in any organisation and it is easy to adapt as the model does not have any universal format, which allows companies to modify and develop their own framework of measurability, depending on their objectives, policies and geographical boundaries (Slipper & Hall 2011).

Figure 1: The Triple Bottom Line Model (Source: SRI-Connect, 2016)



The above Venn diagram clearly shows that sustainability in any business depends on its positive impact on the three factors - society, economy and environment, and it is evident that organisations definitely needs to know, what is required of them at different organisational levels to achieve the sustainable computing within the organisation.

The necessity of the sustainable computing can also be realised with the reported rapid increase in the power demand, e-waste management and the performance expectations from IT in the future. As it is evident through research (The Green IT Global report 2009), that more and more companies worldwide are now willing to commit themselves to take measures to deploy sustainability and adapt to various procedures and policies for the same; it is an important question to ask if the organisations in Oman are equally committed and list sustainable computing as one of the critical issues of their organisational strategy. Moreover, a bigger question to ponder upon is the level of awareness on this issue, when it is not at all significantly noticeable in Oman. As per the Oman Environmental Services Holding Company S.A.O.C (2016), Beah, the iconic and probably the most important body to establish waste management system in Oman, mentions that they are still in the process of adapting and establishing the system and procedures towards effective e-waste management system. However, no significant implementations of technologies or procedures in the field of e-waste management are evident in Oman.

As reported by the United States Environment Protection Agency (2015), the energy which can be saved by recycling of about one million laptops can be equated to the yearly energy consumption of 3,500 homes in the United States. The agency further emphasise on recycling of electronic products as many natural resources such as metals, glass etc. are used to manufacture these products. Therefore, carefully planned recycling of the electronic products will not only help in conserving natural resources but also help in the reduction of harmful greenhouse gas emissions and pollution of air and water. As per the sustainability plan of Alberta University (2016), proper mechanism and procedures must be developed for cautious collection and delivery of all e-waste to a specialized recycling company for the above mentioned reasons.

Even though, e-waste management is one of the key requirements of sustainable computing, the goal of sustainable computing in organisation cannot be achieved just by developing e-waste management procedures and policies. There are many other solutions such as consolidated servers and storage, shifting to networked laser printers, using energy star products, virtualisation and cloud computing, thin-client computing etc., which can be implemented to achieve the goal of sustainable computing in a company (CDWG 2016). Moreover, such solutions and technologies not only aims to achieve sustainability in IT but also help in overcoming the cost impediments within an organisation.

Cloud Computing can be perceived as one of the most innovative and revolutionary concept in the field of ICT and is seen as another potential solution towards the deployment of sustainable computing in organisations. As predicted by International Data Corporation (2014), the cloud service will witness the growth up to $127 billion by 2018, which will represent five-year compound annual growth rate of 22.8%. It is estimated, that this will be six times the rate of overall growth of global ICT market. Many academic organisations in the developed countries have started adopting and implementing cloud computing to increase cost effectivity due to the reduction in the budget given by the government (Sultan 2010). However, despite all the benefits of cloud computing such as pay as per the usage policy, dynamic allocation of resources and reduced operational cost; the pace of implementation is very slow among the academic institutions in developing countries.

Academic literature review on cloud computing has identified that there is still not much research done on finding the reasons for why decision makers and IT experts are still not showing a complete shift, despite the fact that cloud computing provides high performance IT infrastructure to the organisations (Sabi H M, et al. 2015).

Thin Client computing also contributes to minimise the energy consumption by manifold in comparison to traditional desktop computers. Moreover, thin clients also reduce the cost and energy for air-conditioning as they do not need fans and emit much lesser heat. In addition, thin client computers require much lesser raw material and last longer with an average life span of seven to eight years (CDWG 2016). Many organisations are choosing thin clients and adapting to a virtualized desktop infrastructure with centralised operating system and applications. Moreover, the implementation of thin clients also ensures reduced power consumption and reduced carbon emissions. Virtual desktop infrastructure using thin client, provides the similar experience as individual desktops but consumes comparatively much lesser energy. The implementations of thin client installation in the server infrastructure consume only 8 to 14 watts of electricity, which is only a fractional part of the energy consumed by most individual desktops. As a result, significant carbon reduction was evident with only 564 to 988 metric tons of carbon released, which is equivalent to the yearly energy consumed by 80 to 102 homes (Penn Information Systems and Computing 2016)

In the interest of the global community, Information Technology Authority (ITA) of Oman has also proposed and taken initiative in the field of sustainable IT within e government Oman and planned to extend these green initiatives and spread awareness among the other organisations in the Country. The information elicited from some subject matter experts throw the light on the plan, which outlines the major directions such as developing standards, recycling e-waste, creating awareness and disseminating global best practices for sustainable computing. Moreover, ITA Oman claims to have an active in-house sustainability plan, which includes structured procedures and practices for issues like recycling e-waste, energy management and carbon footprint reduction. The “Green Initiative” taken by ITA Oman, further aims to create a sustainable digital environment across the country with resources in hand (Information Technology Authority, 2016). However, the implementation of such initiatives in the other organisations across the country is still daunting and needs to be assessed, measured and monitored through exploratory research and deep reflection. As rightly stated by Murugesan (2008), Green IT is and will continue to be a necessity and not an option for the global IT community.

3. The Methodology

The data were collected through a well-structured questionnaire from three niche academic organisations in the Muscat region of Oman to assess the level of knowledge and practices adapted for sustainable computing. The questionnaire was divided into two sections, where the first section aimed to elicit the demographic information of the participants and the second section concentrated on the awareness of sustainable computing among the employees and the culture of sustainable computing within the organisation. The reliability of the questionnaire was checked through the split half method and the measure of reliability was 91%.

After analysing the above mentioned findings, the research further extends towards establishing the need for raising awareness and imparting training to deploy the culture, practices and procedures of the sustainable computing in the organisation. However, the objective of the implementation of sustainable computing can only be achieved if the

organisations accept their duties and roles towards the environmental concerns and treat the same as their corporate social responsibility, and add the objective of adopting sustainable IT practices as one of the critical success factors in organisational planning and defining organisational culture.

The above mentioned need was recognised and established by the method of pre-test and post-test inferential statistical analysis. A test of 25 questions related to practical and conceptual knowledge on sustainable computing was given to the participants and the scores were calculated on their existing knowledge and awareness of the topic. Later, with the intention of raising awareness and educating the participants with the general and basic knowledge and understanding of sustainable computing concepts, practices and procedures; a self-instructional module was mailed to participants. To complete the process, the same post-test was given again to the participants and the knowledge was calculated to confirm that there was a significant increase in the level of awareness.

The researcher carefully analysed, assessed and measured the effectiveness of the Self-Instruction Module (SIM) on the knowledge of the respondents and thus, carefully explored if the following hypothesis can be established.

H1: *There is an alarming ignorance about sustainable computing in academic organisations in Oman.*

H2: *The average post-test scores of knowledge are significantly higher than the average pre-test scores.*

4. Data Analysis and Findings

The research was conducted on the total number of 120 participants (N=120) in which the percentage of male respondents was 65% and the percentage of female respondents was 35%. 43% of the total respondents had the experience of fewer than 5 years, 33% were in the category of 5 to 10 years of work experience and 24% were having the wealth of more than 10 years of experience. The further analysis stated that the 20 % of respondents worked for less than 3 hours on computers every day, 28% worked every day for 3 to 6 hours and a majority of 52% of respondents worked for more than 6 hours on computers every day. Moreover, the data elicited also stated that 68% of respondents in a majority, owned and purchased more than 2 computers in their work life span, which will further emphasise on the need of exploring the facts about the recycling and the e-waste management of the old computers and other electronic equipment.

Figure 2: percentage distribution of the respondents on the basis of the gender

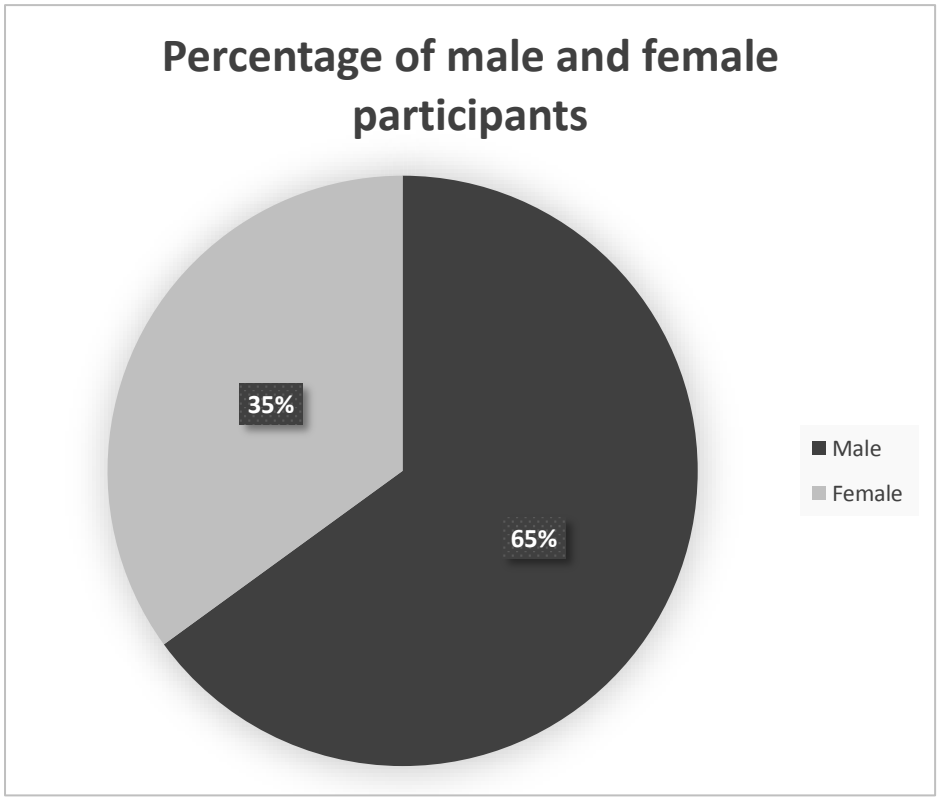


Figure 3: Percentage distribution of the respondents on the basis of work experience

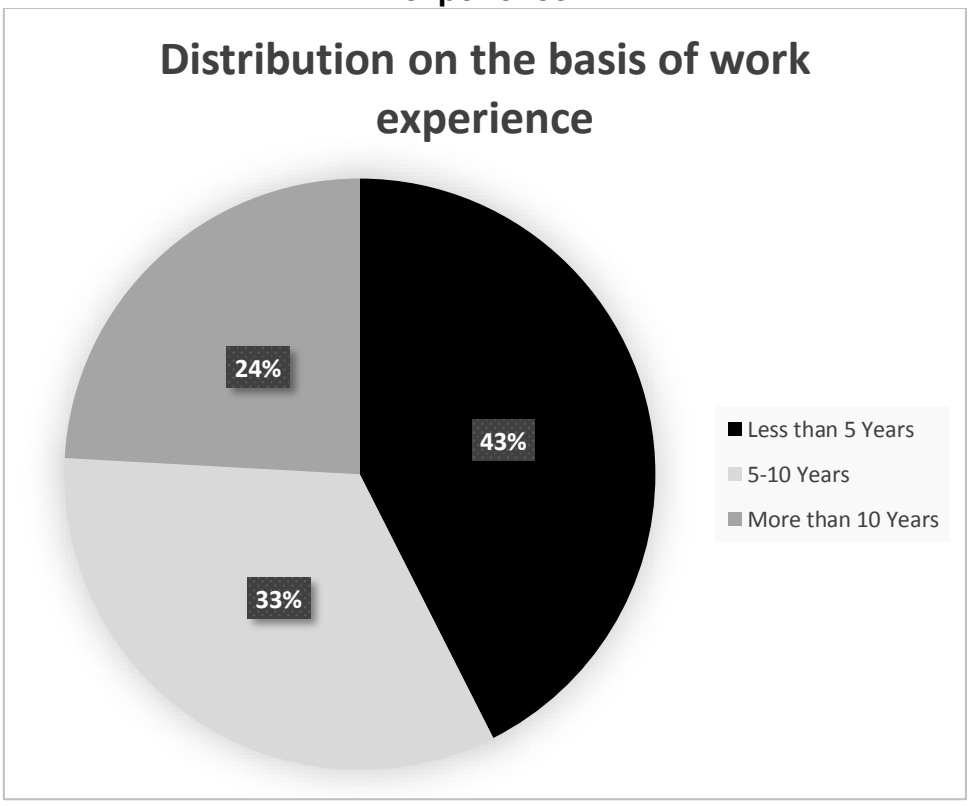


Figure 4: Percentage distribution of the respondents on the basis of their workload on computers

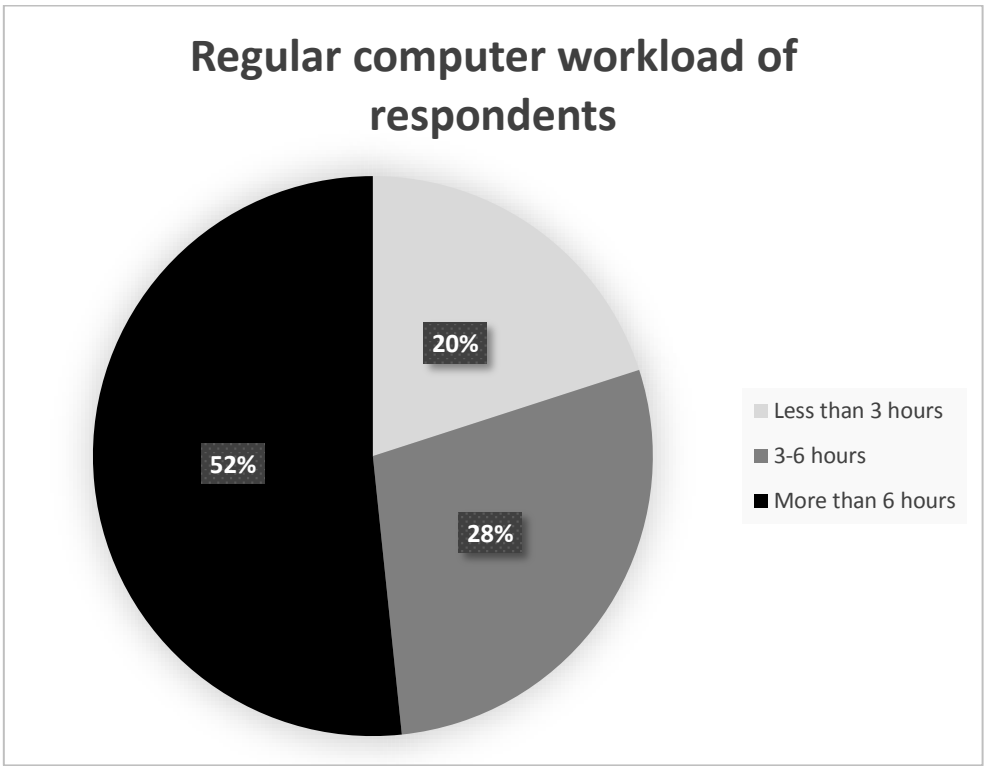
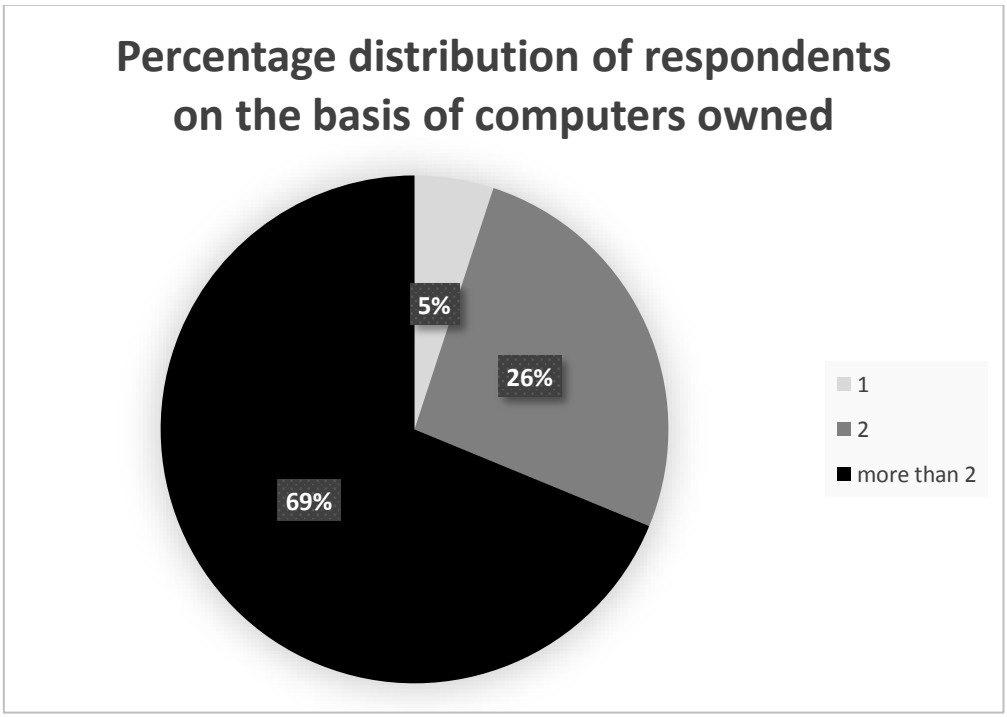


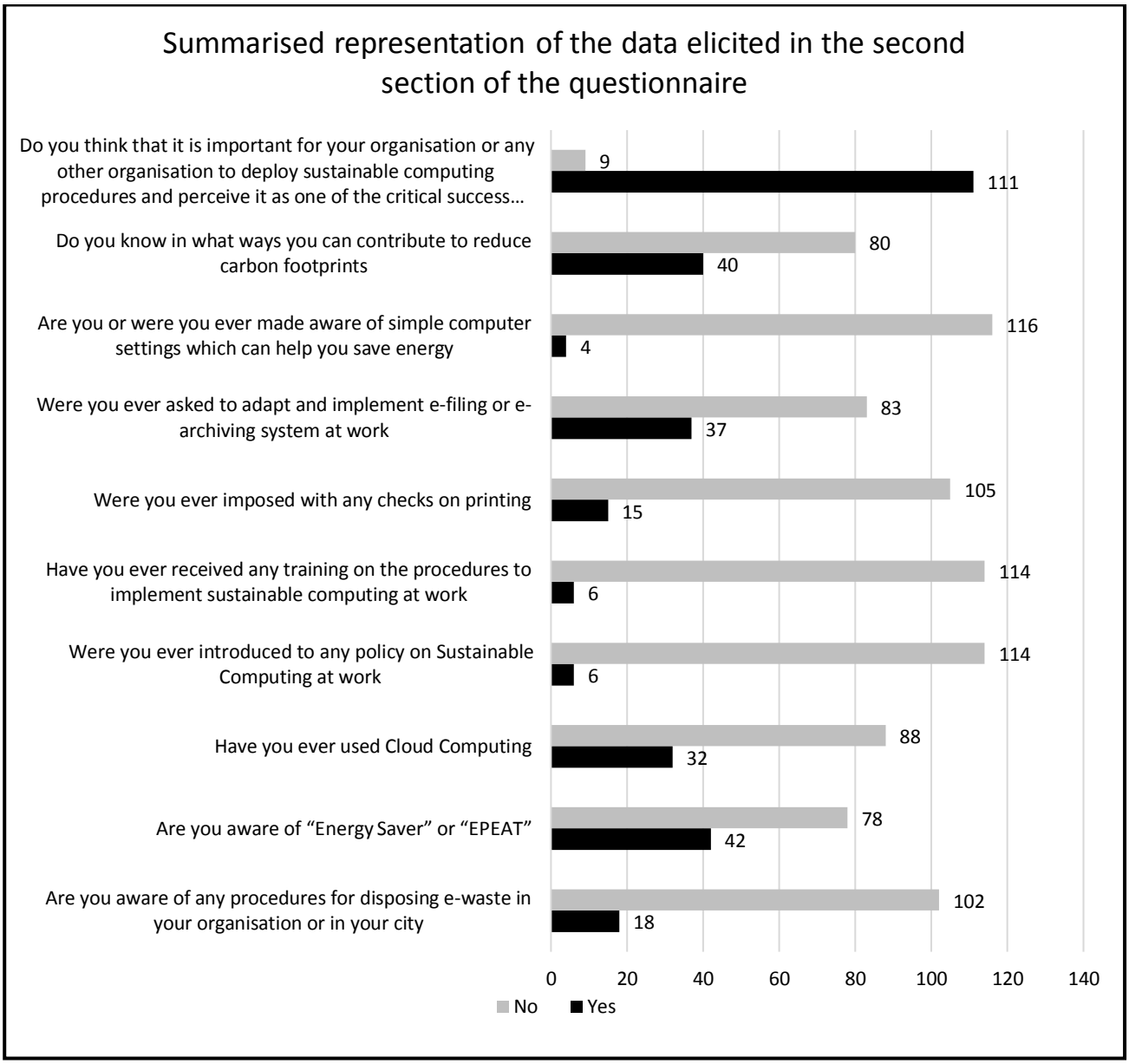
Figure 5: Percentage distribution on the basis of computers owned by the respondents



Further findings of the level of awareness towards sustainable computing were alarming as the majority of the respondents were seemed to be naïve on the concepts of sustainable computing and exhibited the noticeable negligence towards basic terms, practices and procedures. However, at the same time, the majority of the respondents agreed in consensus for the deployment of sustainable computing within the organisation.

The data elicited shows that 85% of the respondents were not aware of any procedures or mechanisms for electronic waste disposal, which is daunting as the previous section's analysis clearly stated that a large percentage of the respondents purchased more than 2 computers in their work lives. 95% respondents admitted that they never received any training or workshops on the concepts and practices of sustainable computing at organisational level. In addition, 78% of respondents had no idea about the "Energy Saver" labels and neither have they ever heard of "EPEAT", which shows the ignorance towards adopting energy efficient environment-friendly computer and electronic products. On asking, if the respondents have ever used cloud computing, 73% of them have said no, where as 37% of respondents have used cloud computing for various purposes. 95% of respondents have clearly stated that they have never received any training or set guidelines neither for practice nor for the deployment of sustainable computing at work. Moreover, 97% of respondents have admitted that they never received any practical tips on basic computer settings for saving energy. Nonetheless, 80% of respondents had no idea about how sustainable computing can help in the reduction of carbon footprints. 83% of respondents were never asked to maintain any sort of e-filing or e-archiving system and 88% of respondents admitted that they never had any strict checks on printing jobs. Despite the above analysis of data, 93% of respondents in agreement said yes for their organisation to deploy sustainable computing at the level of organizational strategy.

Figure 6: Summarised graphical representation of the data elicited in section 2 of the questionnaire



As it is evident from the above analysis that there is definitely a need of raised awareness among the employees of the academic institutions from where the data were collected through random sampling. This proves that the first hypothesis, which states that there is an alarming ignorance about sustainable computing in the academic organisations in Oman, is clearly accepted. Consequently, in order to confirm the fact that awareness and education about the concepts, research, and practices of sustainable computing can definitely bring a change in perspective and attitude of the employees towards the implementation of the sustainable computing best practices in their work culture; a self-instructional informative module was mailed to the respondents to delineate the knowledge towards the said objectives within an organisation. After given time to the respondents to educate themselves through the module mailed, the test was again given to the respondents and the results then showed significant growth in the knowledge of the respondents. The scores for both pre-test and post-test were out of 25.

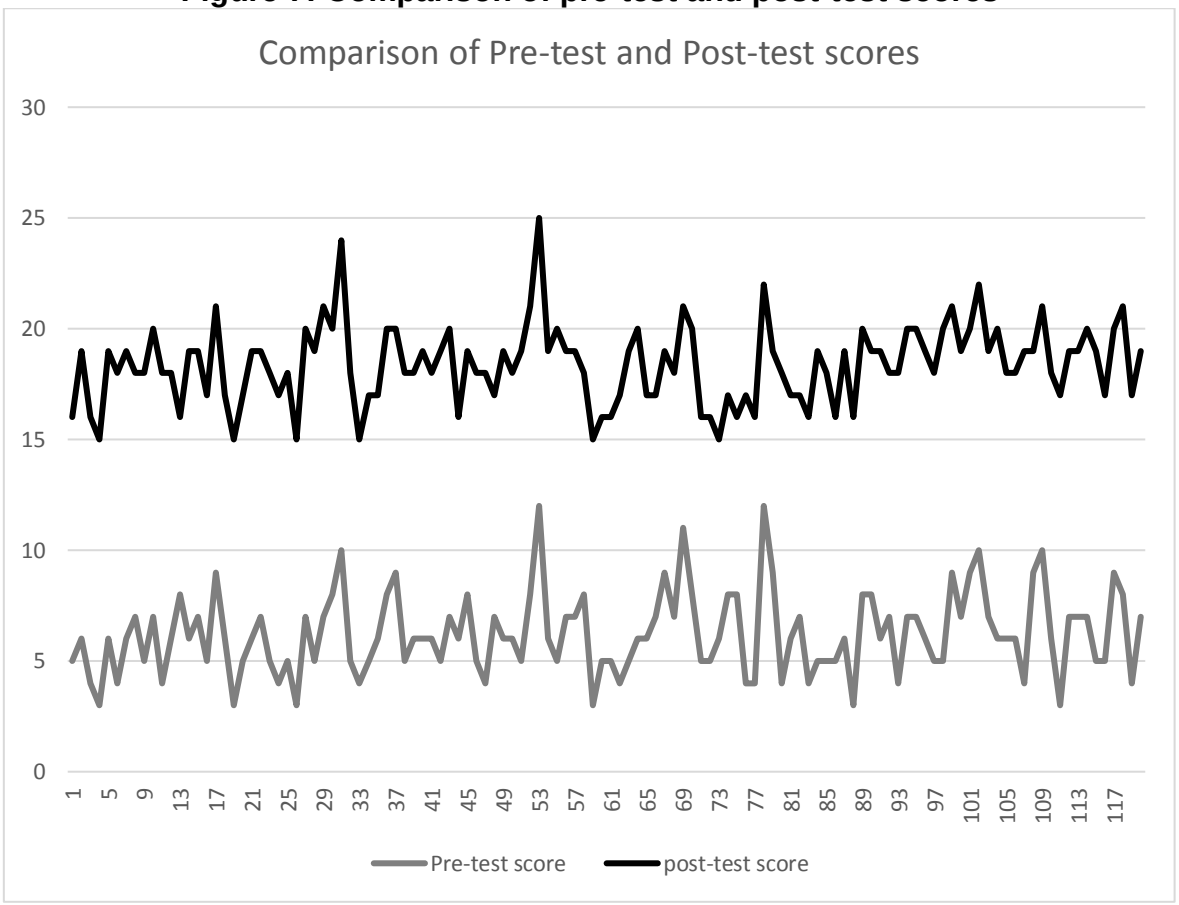
Comparison of pre-test and post-test scores

Table 1: Statistical Analysis of Pre-test and Post-test scores

Statistical Function	Pre-test	Post-test
Mean	6.2	18.4
Max	12	25
Min	3	15
Standard Deviation	1.9	1.8

The mean score for the pre-test was calculated to be 6.2, whereas the mean for the post-test scores was 18.4. Therefore, the significant growth in the knowledge can be seen clearly with the increased mean score of the post-test results. The minimum score increased from 3 to the score of 15 and the maximum score also increased from 12 to 25. The growth can be very clearly seen with the above presented statistical analysis of the pre-test and post-test scores. The standard deviation of 1.8 is quite low which shows the uniformity in the growth of the knowledge. The growth can be more clearly perceived and interpreted with the graphical representation of the scores in both cases.

Figure 7: Comparison of pre-test and post-test scores



Paired t-test analysis

Table 2: Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test score	6.23	120	1.87	.171
	Post-test score	18.39	120	1.79	.164

Table 3: Paired Sample Correlations

		N	Correlation	Sig.
Pair 1	Pre-test score & Post-test score	120	.713	.000

Table 4: Paired Samples Test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pre-test score – Post-test Score	-12.167	1.392	.127	-12.418	-11.915	-95.729	119	.000

The p value < 0.05, clearly indicates that there is a significant difference in the means of the pre and the post-test thus proving that the treatment/intervention was successful, and the proposed hypothesis which stated that the average post-test scores are significantly higher than the average pre-test scores, is accepted.

5. Summary and Conclusions

In conclusion, the research analysis clearly confirms to the fact that, there is an alarming rate of ignorance towards sustainable computing practices in academic organisations in Oman and there is a definitive need for more training and education in the field of sustainable computing in academic organisations in Oman. Therefore, it is necessary to develop the procedures and policies to implement sustainable computing within the organisation through continuous training and support. In addition, a complete shift in attitude towards adopting sustainable computing procedures is required. However, this creates a tremendous opportunity to conduct further explorative study and research in the field of adapting sustainable computing as a corporate social responsibility and develop a more practical framework for the same. The effectiveness of the self-training module was confirmed by the Inferential statistical analysis and the paired t-test clearly proved that the intervention was successful. Moreover, through intensive literature review and careful examination of the existing nationwide scenario, it is evident that only limited initiatives have been taken in this field and there hasn't been any such research conducted before, which was further supported by detailed inferential statistical analysis. Therefore, the scope to perform such intervention experiment becomes extremely important in the nation. This was further validated by the research council in Oman, where the emphasis was given on distributing the self- instructional module homogeneously to various other organisations in Oman.

To devise an integrated sustainable corporate model, a holistic approach must be adopted towards measuring the success of a business and perceiving success not just in economic and financial growth but also in the standards set up and achieved for social and ecological objectives. Triple bottom line model, as discussed earlier in this paper, can be used and adapted as a conceptual framework for measuring a holistic success of an organisation. However, the model still lacks the practical procedures and guidelines, which is required by the organisations in order to successfully deploy sustainable computing within their corporate setups at different levels. Moreover, the other limitation is to further measure sustainability in terms of three defined key areas through continuous research. The challenges in implementing sustainable IT are immense. However, the objectives can be met through a positive attitude toward addressing environmental concerns and adopt forward-looking, sustainable computing policies and practices.

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