Environmental Engineering and Management Journal

December 2014, Vol.13, No. 12, 2999-3007
http://omicron.ch.tuiasi.ro/EEMJ/

"Gheorghe Asachi" Technical University of Iasi, Romania

GREEN INFORMATION TECHNOLOGY (GIT) AND GENDER DIVERSITY

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Abstract

Over the past few years, green computing has received an increasing amount of attention since it is considered as one of the critical factors for protecting the environment. This study investigates gender diversity in terms of applying Green Information Technology (GIT) based on the differences between significance tests result for males and females. For this purpose, a survey was conducted among IT professionals from public and private sector organizations since GIT is a new concept and these professionals are expected to have more awareness on this issue. Six factors were included in the analyses. Interestingly, the results indicate that gender diversity exists only when individuals intend to purchase new hardware and when considering the type of IT usage.

Key words: environment, gender, Green Information Technology (GIT), Information and Communication Technologies (ICT), regression

Received: July, 2011; Revised final: August, 2012; Accepted: August, 2012

1. Introduction

Information Technology (IT) can have a detrimental influence on the environmental footprint of organizations (Siegler and Gaughan, 2008). Expenditures with regard to IT have important implications for the environment, and the increasing use of this technology in recent decades has undoubtedly contributed to additional power consumption as well as a potential overuse of scarce resources (Elliot and Binney, 2008; Hedwig et al., 2009). For instance, in 2008 Gartner predicted that 80% of data centres will be running at their maximum available power and cooling levels by 2010 (Uhlman, 2008). Gartner also predicts an increase in server acquisitions in 2010 and 2011 which will further exacerbate the issue (Kumar, 2010). According to Dembo (2008), IT is quickly surpassing air transportation in terms of its carbon footprint. For these reasons, concerns regarding climate change along with an increased environmental awareness have spurred interest in sustainable development and GIT, both in the field of information systems (IS) (Melville, 2010; Watson et al., 2010) and among IT practitioners (Symantec, 2009; Webb, 2008).

Green IT refers to the use of IT resources in an energy-efficient and cost-effective manner (Bose and Luo, 2011). According to Siegler and Gaughan (2008), Green IT refers to information technology and system initiatives and programs that address environmental sustainability. It has been argued that IT holds the promise of being instrumental in combating the negative environmental effects of the world's rapidly developing economies (Erek et al., 2009). However, environmental issues underlying IT and IS often have no clearly defined ownership in organizations (Siegler and Gaughan, 2008), and the IT/IS function is often not considered by most of the organizations in their assessment of their

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environmental footprints (Huang, 2008). The IT industry has recognized the green IT/IS issue and identified a variety of consulting opportunities (IDC, 2008; LaMonica, 2008; Siegler and Gaughan, 2008; West, 2008). An example for this is the IBM's Green Sigma consulting practice (Hoover, 2008). Green IT can reduce the environmental impacts directly by (1) using improved materials and technology in the manufacturing of IT components, and making IT component and infrastructure more energy-efficient; or indirectly (2) by developing more efficient information systems and technology solutions to support business initiatives in reducing their negative environmental impacts (Chowdhury, 2012).

Experts showed that more than 30% of greenhouse gas emissions derived from industrialized countries (Ciubota-Rosie et al., 2008). To date, GIT research has focused primarily on hardware design and an energy-efficient use of IT (Berl et al., 2009; Gabriel, 2008). Some organizations are now actively pursuing green IT solutions for a multitude of reasons and benefits, including reduction of power consumption, lowering costs, carbon emissions, reducing the environmental impact, improving the system's performance and use, increasing collaboration and interaction amid constituents, saving space, and creating an agile workforce (Bose and Luo, 2011). Most of the literature focused on every day use and practitioners concerned with describing technologies, such as green supercomputers (Schaffhauser, 2008) and green data centers (West, 2008). It is important to note, that Jenkin et al. (2011) found no articles on green IT/IS in leading MIS journals, and could find only twenty scholarly articles in peer-reviewed journals and eighteen conference and working papers. Further, in a majority of GIT papers within IS to date, there is a lack of social perspective (Butler and Daly, 2009; Erek et al., 2009).

Over the last two decades, gender has become one of the crucial factors in ICT studies (Hasan, 2010), and its influence of gender on new technology adoption has generated substantial debates in the field. However, related findings have not proved to be conclusive enough yet. For example, in one study, Seyal and Pijpers (2004) considered major factors (including gender and age) influencing senior government employees' attitudes towards the use of the Internet. Also, Fang and Yen (2006) and Hills and Argyle (2003) reported that the level of Internet usage is related with gender, while Zhang (2005) found no significant gender differences with regards to using the Internet for different purposes among 680 telecommunication employees. In three other recent studies, Smith et al. (2008), Luan et al. (2008), and Jackson et al. (2008) reported that gender is not a significant indicator of difference in ICT use. However, their findings were contradictory by reports from Teo and Lim (2000) and Nachmias et al. (2000). Schumacher and Morahan-Martin (2001), DeYoung and Spence (2004), and Potosky (2007) also support this view. As for their share, Schumacher and Morahan-Martin (2001) suggested that males exhibit greater competency and comfort with the Internet and computers and tend to spend more time online than females. Apart from these, Jaeger (2003) studied the e-government phenomenon and reported that, in general, demographic factors including gender have a significant impact on the individuals' attitudes towards the use of IT. According to Akman et al. (2005) noticeable gaps exist between different genders in using e-government. Slyke et al. (2010) recently noted that among the many characteristics that impact the use of e-commerce, one that has received relatively little attention is gender and clear evidence suggests that men and women differ in their beliefs regarding the use of information technology-related innovations, including e-commerce.

Green IT and green information systems have become major areas of research for the past few years. However, to date little research has taken place on information and sustainable development in general, and on the environmental impact of information services in particular (Chowdhury, 2012). Regardless of ever-increasing energy costs, researchers, practitioners, and governments are now seeking effective initiatives to regulate inefficient energy use by global business enterprises. For instance, the UK government aims at decreasing green house gases by 20% before 2020 (Capra and Merlo, 2009).

IT now plays a crucially important role in environmental and energy fields related to Green IT because the latter may refer to three primary research areas: (1) energy efficiency of IT, (2) eco-compatible management of the lifecycle of IT, and (3) IT as an enabler of green governance (Capra and Merlo, 2009). The emergence of green IT as an important strategic issue has been triggered by the recognition that environmental sustainability, which was once little more than a moral incentive for companies, has now become indispensable to doing business and, hence, an imperative for IT (Esty and Winston, 2006;Murugesan, 2008; Velte et al., 2008; Watson et al., 2010). The breadth and depth of the knowledge on the greening process are steadily evolving and increasingly studied by organizations to help them develop their green IT strategies (Bose and Luo, 2011).

The green IT strategy, design and practice initiatives within organizations have recently evolved gradually into an active research area in the information system discipline, and, presently, there are few empirical researches in the area of green IT (Bose and Luo, 2011; Jenkin et al., 2011). It is further supported by Huang (2008) that, even though research to date suggests that organizations often neglect to incorporate the IT/IS function into their environmental assessments and fail to allocate personnel to address environmental issues concerning IT/IS (Siegler and Gaughan, 2008), few empirical studies have examined whether, and if so, how, organizations are incorporating IT/IS into their

environmental management practice (Jenkin et al., 2011). Jackson et al. (2008) study findings indicated race and gender differences in the intensity of IT use. Recent studies have found that gender gaps are diminishing as increasing numbers of women are using computers and its applications. However, due to the conflicting nature of the results, more research should be conducted on the role that gender plays in new technology adoption and use (Li et al., 2008). Gefen and Straub (1997) also found in their study that a genuine gender effect exists in some aspects of IT diffusion. They suggested that researchers should include gender in IT diffusion models along with other cultural effects. Furthermore, gender studies related with usage of IT helps in formulating public and private sector policies regarding environmental impact and energy consumption and, based on such research studies, revision in already-proposed plans may be required. Having considered all these, the objective of this study is to observe gender diversity in adopting the emerging green IT in terms of gender relationships between perceived usefulness, awareness, and behaviors towards GIT among IT professionals. There is a great degree of awareness and acceptance of green computing among IT professionals (Akman and Mishra, 2014).

This paper is organized as follows: The following section introduces the theoretical development for the hypotheses. Afterwards, research design is stated clearly. The results of the study are then presented and discussed. Finally, the paper concludes with conclusions, limitations, and directions for future research in this area.

2. Hypotheses

The main purpose of the present study is to investigate gender diversity in terms of adopting GIT practices based on a sample of male and female IT professionals. The dependent variable of the study is the "level of practicing GIT" by each gender. The independent variables were categorized into two empirical factors: (i) perceived usefulness (usefulness practicing GIT for reducing waste, usefulness practicing GIT for environmental effects, and worthiness of practicing GIT); and (ii) awareness and behaviors (awareness of GIT, considering GIT when purchasing new hardware and considering GIT depending on the type of ICT usage). Fig. 1 demonstrates a model for research. As to the justification for empirical factors and their corresponding hypotheses, it is provided below.

Perceived usefulness:

Recent developments in IT have lead to an increasing emphasis in computer applications including adoption of GIT. Despite evidence of increasing use of new technology among individuals, the theoretical developments focused on GIT have been few and not been able to thoroughly investigate issues in adopting GIT usage. In studying the levels of user-acceptance of new technologies, the analysis of personal perceptions appears to be amongst the most cited ones (Park et al., 2007), while perceived usefulness constitutes an important group of factors in personal perceptions (Chow and Chen, 2009; Park et al., 2007).

Recently, various researchers have studied the use of ICT from different perspectives. For example, Ting and Grant (2005) investigated how employees use ICT to carry out their daily work. They indicated that factors regarding such usefulness bears a significant impact on ICT usage. However, as reported by Frank and Lewis (2004), there are striking differences depending on each individual's personal characteristics. Apart from these, the Technology Acceptance Model (TAM) (Davis, 1989), as being one of the most widely-accepted intention-based adoption theories, suggests that percieved usefulness is a fundamental determinant in predicting an individual's intention to use computer technology (Ma, et al., 2005). On the basis of this rationale, the hypothesis $H1_i$ (i=1, 2, 3) is formulated as:

$H1_i$: There is not any gender diversity in practicing GIT in terms of individual's perceptions of usefulness.

Awareness and behaviors:

To date, an extensive number of studies has addressed the relationship between behavioral and attitudinal factors influencing the pattern of ICT usage. For example, Losh (2003) repored that a number of differences in the purpose and nature of ICT usage should be expected. The available literature also provides indications of association between demographic factors and behaviors. For instance, Taylor et al. (2003) reported that the ICT usage pattern may have different dispersions for different gender groups depending on their behaviors.

In their recent study, Mishra et al. (2014) and Chow and Chen (2009) refer to the Theory of Reasoned Action (TRA), which is among the most popular belief models (Ajzen, 1991). They stated that an individual's intention to perform or not to perform a given task is determined by their attitude towards behavior. Furthermore, behavioral intentions depend not only on personal characteristics, but also on the level of awareness as stated by Cronan et al. (2005) and Akman et al. (2005).

Additionally, Cronan et al. (2005) suggested that there is an increased degree of acceptance among researchers that the area of various issues for the use of ICT must be explored further. Based on this, the present study proposes the hypothesis $H2_i$ (i=1, 2, 3) as follows:

$H2_i$: There is not any gender diversity in practicing GIT in terms of personal awareness and behaviors.

3. Research design

A survey questionnaire corresponding to the proposed hypotheses was developed.

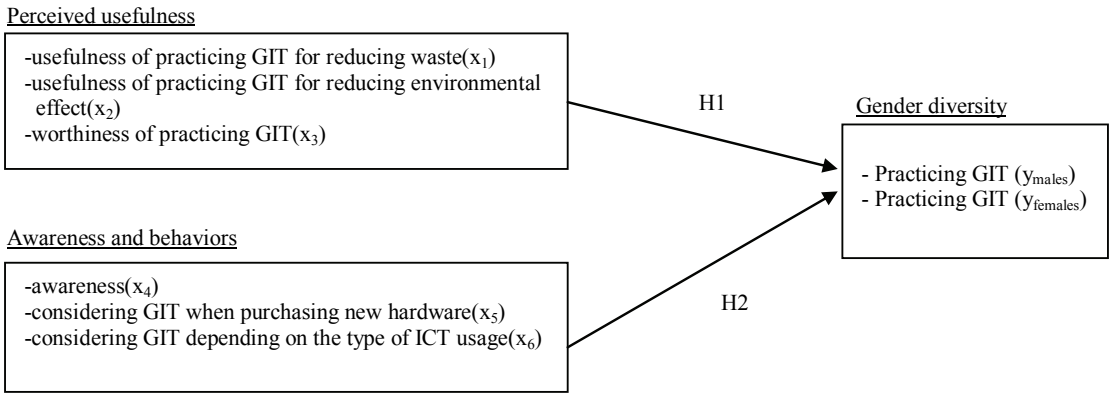

Fig. 1. Research Model

A pilot version of this instrument was face-validated and revised based on the suggestions from a group of IT professionals. The questionnaire contains 11 items, and each item reflects a discrete variable as given in Table 1 along with the definitions, scales, and the range of values for these variables. The variable "gender" has been used for the purpose of data classification, while "sector", "age", and "experience" have been set for descriptive purposes. The variable "practice_GIT" is the dependent variable, whereas the others (X_i, i =1, 2,…, 6) constitute independent ones.

The respondents were IT professionals from major public and private sector organizations who were the attendees of an annual one-day meeting on issues (problems and developments) in the use of IT in organizations, organized by the Turkish Informatics Association (TIA). The invitations were limited to 190 organizations and were selected from government and private sectors using "judgment sampling". A total of 182 completed survey questionnaires were received. Twenty-five responses were discarded from the analysis due to the existence of unqualified data.

The overall internal reliability as measured by Cronbach alpha (Brown, 2002) was found to be 0.874, meaning that the data is reliable since 0.7 and above is usually the acceptable threshold (Yu, 2007). In the mean time, factor analysis was performed, whose summary of loadings for decision variables X_i (i=1, 2,.., 6) has been provided in the last column of Table 1. The factor loadings of constructs were observed to be ranging from 0.503 to 0.745, which means that the constructs are reliable. The regression technique was also utilized to separately represent the relationships between the dependent and independent variables for each gender. The differences in the nature of significance of the relationships for males and females were, then,used to decide the gender diversity, as reflected in the last column of Table 3.

4. Results

The findings of this paper have been categorized into descriptive and actual test results.

Descriptive Results

The demographic profile of male and female respondents is summarized in Table 2. The percentage of the male respondents appears to be more (62.4%), and most of the respondents were from public sector organizations (53.5%). Of the male respondents, 8.2% was above 50 years of age and those between 31-40 and 41-50 years of age constitute 22.4% and 26.5% respectively. These percentages are 10.2, 33.9, and 16.9 for female respondents. In general, most of the respondents belong to the group that aged less than 30 for both males (42.9%) and females (39.0%). The distributions indicated the highest percentage for those professionals with less than 5 years of experience for males (32.6%) and females (35.6%). Naturally, age and experience show parallel dispersions for both genders.

Test results

Both the hypotheses were investigated at 5 percent significance level for each gender separately. The results of the regression and its respective p-values are given in Table 3 for each gender. The last column of the same table also provides a summary of the existence of gender diversity based on the differences in the significance of the test results for males and females.

Perceived usefulness:

The inspection of p-values (Table 3) indicates:

- "reduce_waste" is not significant for both males (alpha-value= 0.0912, p-value= 0.085) and females (alpha-value= 0.1056, p-value= 0.196). This means there is not any gender diversity in terms of the significance results for the predictive effect of "reduce_waste" in each gender, and $H1_1$, as such, is accepted.
- There is not any gender diversity for the variable "environment_effect" since the regression results show significance at the impact of males (alpha-value= 0.0946, p-value= 0.039) and females (alpha-value= 0.1226, p-value= 0.003). Thus, $H1_2$ is also accepted.

- There is not any gender diversity for the variable "worth_practice" because the regression results show significance for this variable among both males (alpha-value= 0.0875, p-value= 0.000) and females (alpha-value= 0.1143, p-value= 0.000). This concludes that $H1_3$ is accepted as well.

Awareness and behaviors:

The tests results for this group are given in the following.

- Examining p-values in Table 3 reveals that the significance results for the variable "awareness" is of similar nature for both males (alpha-value=0.0867, p-value=0.002) and females (alpha-value= 0.0994, p-value= 0.000). In other words, there is not any gender diversity for "awareness", and $H2_1$ is accepted.
- Interestingly, the regression results (Table 3) reveal different significance levels for the variable "purchase_hardware" between males (alpha-value= 0.0803, p-value=0.014) and females (alpha-value= 0.1220, p-value= 0.600). This implies the presence of gender diversity for the variable "purchase_hardware" and, hence $H2_2$ is rejected.
- Surprisingly, $H2_3$ is also rejected because we observe different levels of significance (Table 3) between males (alpha-value= 0.0859, p-value=0.006) and females (alpha-value= 0.1264, p-value=0.220) for the variable "work_type".

5. Discussion

This paper examines gender differences when practicing GIT with regards to selected underlying factors, which we believe to be most critical according to the widely- accepted theories on intention and belief-based models TAM and TRA. The discussions on the results of this paper mainly focused on the two empirical categories of perceived usefulness and, awareness and behaviors.

Table 1. Summary of research questions and variables

Que.	***Variable***	***Definition***	***Range of values***	***Factor Loadings***
1	gender	What is your gender?	Male, female	
2	sector	Which sector do you work at?	Public, private	
3	age	What is your age (years)?	21- 30, 31-40, 41-50, >50 61 or more	
4	experience	How long have you been working (years)?	0-5, 6-10, 11-15, 16-20, >21	
5	practice_GIT (Y)	Do you generally consider practicing GIT while using ICT?	very much, much, average, little, not at all	
6	reduce_waste (X_1)	Do you think practicing GIT is useful in reducing waste?	very useful, useful, average, little, not at all	0.696
7	environment_effect (X_2)	Do you think practicing GIT is useful in reducing environmental impacts?	very useful, useful, average, little, not at all	0.745
8	worth_practice (X_3)	To you, is practicing GIT worthy?	very much, much, average, little, not at all	0.678
9	awareness (X_4)	How aware are you of GIT?	very much, much, average, little, not at all	0.503
10	purchase_hardware (X_5)	Do you consider GIT related factors when purchasing new hardware?	very much, much, average, little, not at all	0.646
11	work_type (X_6)	Do you intend to consider practicing GIT depending on the type of your ICT usage?	very much, much, average, little, not at all	0.696

Table 2. Demographic profile of respondents

Variable-description	***Male (N=98)***				***Female (N=59)***			
	N	Percent.	Mean	SD	N	Percent.	Mean	SD
Sector		100.0	1.459	0.501			1.475	0.5046
1=public	53	54.1			31	52.5		
2=private	45	45.9			28	47.5		
Age		100.0	2.000	1.015			1.983	0.991
1= 21-30	42	42.9			23	39.0		
2= 31-40	22	22.4			20	33.9		
3= 41-50	26	26.5			10	16.9		
4= >50	8	8.2			6	10.2		
Work-experience		100.0	2.459	1.356			2.508	1.501
1= 0-5	32	32.6			21	35.6		
2= 6-10	24	24.5			13	22.0		
3= 11-15	17	17.4			10	16.9		
4= 16-20	15	15.3			4	6.8		
5= >20	10	10.2			11	18.7		

Table 3. Test Results

			Male		*Female*		*Diversity in test results*
Emp. Factor	***Predictor***	***Hyp.***	***coeff.***	***p-val****	***coeff.***	***p-val****	
perceived usefulness	reduce_waste	$H1_1$	0.0912	0.085	0.1056	0.196	NOT DIVERSE (both insignificant)
	environment_effect	$H1_2$	0.0946	0.039*	0.1226	0.003*	NOT DIVERSE(both significant)
	worth_practice	$H1_3$	0.0875	0.000*	0.1143	0.000*	NOT DIVERSE (both significant)
awareness and behaviors	awareness	$H2_1$	0.0867	0.002*	0.0994	0.000*	NOT DIVERSE (both significant)
	purchase_ hardware	$H2_2$	0.0803	0.014*	0.1220	0.600	DIVERSE (male significant and female insignificant)
	work_type	$H2_3$	0.0859	0.006*	0.1264	0.220	DIVERSE (male significant and female insignificant)

**indicates statistically significant at 5% significance level*

Also, as GIT is the subset of IT and only little empirical research is available on GIT, we have compared these with IT studies instead.

Perceived usefulness:

The results provide strong indications for the absence of gender diversity for the factors in this category. First of all, p-values in Table 3 indicate that the variable "reduce_waste" does not show any predictive effect on "practicing_GIT" in each gender. Surprisingly, the observations are just the opposite for the variables "environment_effect" and "worth_practice", which means they have statistically significant impact on "practicing_GIT" among males and females. These conclude that "gender" does not form any diversity for any of the factors pertaining to perceived usefulness. This may be partly due to the fact that our respondents were IT professionals, and that it is more likely to expect no gender differences in their perceptions regarding computer technology in groups with similar backgrounds (Akman and Mishra, 2010).

Another plausible explanation may be based on the fact that the traditional dominating role of males in the society is not valid in professional life, and that males and females are equally likely to share the opportunities and developments, including ICT. Recently Maldifassi and Canessa (2009) also found that gender has the least importance when explaining differences in the use of IT and perception regarding its usefulness. They have further observed that, on average, for different social strata, females tend to have a relatively higher perception of usefulness than males, but the difference is small. Similarly, although worldwide, there is a gender gap in terms of access to IT favoring males (van Dijk, 2005), and that the gender gap in the U.S. -once substantial- has disappeared (Pew Internet & American Life Project, 2006). In another study, Zhang (2005) reported the view that there is no statistically significant difference in terms of ICT subscale usefulness between male and female employees. Contradictory findings have also been reported in the literature. For example, Bebetsos and Antoniou (2009) reported gender differences in terms of perceived usefulness in their research among university students. The most obvious explanation may be based on the differences between the nature of the samples and the factors subjected to gender differences.

Awareness and behaviors:

As expected, awareness was found to have a significant impact in practicing GIT for each gender. In other words, there is no gender diversity in this respect. Our finding is in line with that of Cogner et al. (1995) and Koyuncu and Lien (2003). The former reported that, regardless of gender, awareness is a crucial issue in the information society; whereas the latter stated that individuals possessing more ICT experience compared to others are likely to apply it more effectively since they are likely to find better solutions in a shorter period of time and in a more efficient way. More recently, the results of Chow and Chen (2009) indicate that the IT users' intention to exercise green computing highly depends on their awareness of the same issues. Forcht et al. (1988) also pointed out that awareness of various issues concerning ICT has a major impact on attitudes towards the use of IT and, as also suggested by Hsu and Shiue (2008), organizations should provide awareness programs for their employees.

Surprisingly, there is gender diversity in "practicing_GIT" for the remaining factors "purchase_hardware" and "work_type" in this category since these variables show a significant impact on "practicing GIT" among males and not females. A possible justification for this finding is based on the fact that females have a less positive attitude towards computers (Bebetsos and Antoniou, 2009). Furthermore, males and females can perceive and use ICT differently because they have different task preferences (Teo and Lim, 2000). Another reason may be that male dominance, including male resistance to female participation, is likely to shape gender diversity when using computers (Teo and Lim, 2000).

Although, in general, the literature is not conclusive on gender diversity in ICT usage, our finding is indeed supported by various studies. For example, with regards to gender and IT use, a good portion of the research conducted until the turn of the century supports three conclusions. First, males have

a more favorable tendency towards computers and use them more often than females. Second, both genders consider computer-related activities to be stereotypically male ones. Third, females are less attracted to computer courses and computer-related careers than males (Brosnan, 1998; Durndell and Thomson, 1997; Kirkup, 1995; Meredith et al., 1998). Gefen and Straub, (1997) reported that the socio-cultural factors can result in differences in user's responses to innovations in technology. For instance, males and females are found to demonstrate distinct adaptation behaviors in terms of applying a wide range of ICT activities (Kraut et al., 1996, Ling, 2000). In this respect, our finding is also supported by Hasan (2010), who reported that both genders exhibit diverse perceptions and behaviors toward the use of ICT services.

6. Conclusions

The present study has examined the impact of gender diversity on IT users' perceptions and behaviors towards practicing GIT. The factors incorporated in the analysis were selected with due consideration of the elements of TAM and TRA, and grouped under two empirical categories of perceived usefulness, and awareness and behaviors. Interestingly, the results revealed that none of the factors involved in the "perceived usefulness" category shows any gender diversity. This is because the variable "reduce_waste" does not have any significant impact on practicing GIT for both males and females, whereas this impact is significant for the variables "environment_effect" and "worth_practice".

The results also indicated that "awareness" is critical, and has significant effect on practicing green computing among both genders. However, male and females have differing opinions when purchasing hardware and when considering work quality in their GIT practices. In fact, males were found to be significantly more responsive than females to green computing, which may also be due to social, cultural, geographical, and economic reasons.

All these suggest that special training programs in organizations, along with awareness-developing advertisements in the media, can be initiated so as to increase the level of public understanding throughout the society.

7. Limitations of the study

The authors of the present paper acknowledge certain limitations in this study. First, this research has been exploratory in nature, and the data collected was based entirely on how the participants have perceived their practices towards GIT, which may possibly limit the generalizability of the results. Replacing such data-gathering technique with interviews instead, can lead to probe the respondents' answers in a better way in future. Second, the sample was limited to IT professionals in this research since GIT is a new concept and IT professionals are observed to have higher awareness on the issue than other groups. This means the sample should be extended to include other groups in future studies as well.

Using larger samples, can obviously, provide more satisfactory insight into the relations towards practicing GIT among different groups of citizens. Third, this study considered the relationships between gender and perceptions/behaviors towards GIT among IT professionals. Therefore, an extension to consider the impact of work climate on practicing GIT in organizations from different sectors would also be of interest.

In this respect the influences imposed by the group under analysis as well as factors regarding administration in different firms may also provide additional interesting results. Finally, the same limitation as addressed by Calhoun et al. (2002), Chirkov et al. (2003), and a number of others is related with the significant impact of culture in using ICT. As such cultural, social, geographical, economic factors deserve a closer look in terms of their impact on organizational as well as personal perspectives in practicing GIT.

Acknowledgement

The authors would like express their appreciation to Payam "Paul" Danesh, of the Academic Writing and Advisory Center, Atilim University, for his assistance in editing the English of the manuscript.

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