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# Awareness of Green Computing practices among Saudi University Students

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## Abstract

The utilization of ICTs in higher education is colossal in almost all universities around the world. However, the university's IT department is the one which devours the most amount of energy influencing the organization overhead and a source of poisonous pollutant. The primary objective of the research is to respond to the essential research question: what is the level of green computing knowledge, habits, attitude and intentions of students towards its adoption? The research will further identify the relationship between subjective and perceived knowledge. Also, the research will give useful insights related to the effect of gender and program of study on it. The research started with a systematic literature review to set and validate the research objectives. The questionnaire was adapted from the authenticated measurement available in green computing adoption studies. The data aggregated were statistically analyzed using a combination of descriptive analysis (percentage and frequency analysis), consistency test by Chronbach's alpha, Independent Sample T-Test and Bivariate Correlation. The finding shows that students from all program of studies are not knowledgeable about green practices. However, the researchers have uncovered a significant reality that computer experience has a stimulus on green computing awareness. The students with high perceived knowledge also have good objective knowledge about green computing. The female respondents reported a slightly higher level of use of green computing practices and a higher level of intention and attitude towards the acceptance of green computing. This useful insight will help the policymakers to formulate and revise their green strategies for embracing green computing in the universities. The research will recommend better ways to incorporate the green computing in the existing curriculum and university research to ensure higher technical skills blended with green skills in future managers, educators, administrators and policymakers. Subsequently, it could be utilized as a contribution to persistent improvement and advancement activities.

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## I. INTRODUCTION

The constant ecological issues like pollution, deforestation, climate-change, and global warming remains a major defies for sustainable development worldwide. Equipped with extraordinary assurance, the United Nations [46] has approved the Paris Agreement with a focal mean to sustain the global response to the peril of climate change, to strengthen the limit of countries to deal with the impacts of it, to require all partners to contribute their best measures of energy through comprehensively chose duties and to fortify these undertakings in the years ahead. Sustainable and green development has been perceived by organizations to be a significant strategic tool when many are under growing social, economic and administrative pressures [12], [16], [29] to contend in the age of thriving Industrial Revolution 4.0. As

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per a report that studied 426 organizations in North America and 1052 organizations around the world, 86 percent accepted that it is imperative to actualize green information technology (GIT) activities [42].
Education, when all is said in done, is an approach to accomplish a sustainable economy [43]. In any case, higher education is progressively intricate yet loaded with possibilities. It has four-fold works, that is, learning & teaching, research, community service, and innovation [14]. The role of higher education in the worldwide economy is extraordinary and noteworthy. If the global economy is going into a specific direction, higher education moves towards a similar direction. It is compelling in forming and re-shaping the global economy. Higher education is the methods towards this end, is the green economy. It needs to acknowledge and receive the green transformation for it to get important to a green economy. Also, the United Nations [45] planned to guarantee that by 2030 all students will gain the information and abilities expected to promote green and sustainable development. The coalition of higher education and industry is endlessly indivisible explicitly in planning students as inevitable industry labourers outfitted with green aptitudes. For the aforementioned grounds, the mindfulness, preparation, and activities of the higher education towards a green transformation is put to address and driven this investigation to discover it out.
Green Computing is concerned about utilizing, reusing, recycling, and disposing of Information Communication Technologies (ICTs) in manners that diminishes the amount of carbon and various hazardous gases that adversely affect the ecosystem [5]. It includes both software and hardware [20], [30] and characterizes green computing as learning and employing more sustainable practices in the planning, design, production, usage and recycling of all ICTs. This incorporates hardware equipment and the related subsystems, for example, networking technology and software systems running on these devices, compellingly and proficiently with no or insignificant effect on the ecosystem [5].
The utilization of ICTs in higher education is colossal in almost all universities around the world. It has become an integral part of the day to day practices of faculties, students, and administrators in the process of learning and teaching. The use of computer applications and social media for learning & teaching, research and edutainment are normal. However, the IT department is the one which devours the most amount of energy influencing the organization overhead and a wellspring of poisonous pollutant. It is estimated that the university students computing usage contributes to 2 percent of the total global carbon emission worldwide [10]. Significantly, students must outfit with IT skills and yet, they ought to likewise aware of utilizing it in a dependable and eco-friendly way. There is significant research accessible about the expansion in Students' ICT proficiency from being digital beginners to digital experts [24] however there is little research accessible which can inform us concerning their environmental literacy about ICT usage. The extant literature focusing on adoption of green computing in higher education reveals that lower awareness level among students was the primary hindrance for the adoption in the developing countries.

### *A. Research Problem*

The extant literature contemplates demonstrating the advantages, issues, practices and difficulties on green computing implementation in developing nations [6]. In any case, restricted work has been done to research the knowledge of students, staff and policymakers on the adoption of green computing experience. Few numbers of research have explored the level of awareness of the university students to the extent what they think about it, adopt green practices [48], [25] but green compliant behaviour is still an ignored zone of research in green IT [15]. It is reported that the most significant factor for the successful implementation of green computing in gulf nations

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is knowledge followed by relatively favourable position, the board support, reasonable resources and government arrangement [5]. There are several studies carried out to unveil the level of awareness among university students in the developing countries like Zambia [28], UAE [1], Uganda [38], Malaysia [4] and Mauritius [18] but limited research has been done in the Gulf countries especially Saudi Arabia. In the extant literature, the relationship between subjective and objective knowledge about green computing and the role of gender and the field of study of students is not explored.

Therefore, the primary objective of the research is to respond to the essential research question: what is the level of green computing knowledge, habits, attitude and intentions of students towards its adoption? The research will further identify the relationship between subjective and perceived knowledge. Also, the research will give useful insights related to the effect of gender and program of study on it.

This useful insight will help the decision-makers to formulate and revise their green strategies for embracing green computing in the universities. The research will recommend better ways to incorporate the green computing in the existing curriculum and university research to ensure higher technical skills blended with green skills in future managers, educators, administrators and policymakers.

## II. LITERATURE REVIEW

A systematic review of literature is carried out focusing on the three topics: (a) use of ICT in higher education, (b) green computing & sustainable development and (c) green computing adoption in higher education.

### *A. Use of ICTs in Higher Education*

In the last two decades, the application of ICT has profoundly changed the practices and procedures of nearly all forms of exertion within business and administration [40]. The use of ICTs in higher education is immense in almost all universities around the globe. There is a continuous increase in the percentage of use of ICTs in the university programs in almost all major fields ranging from learning & teaching to administrative work. Web-based learning resources are regularly used by university professors and students in many countries [32]. It is proven that the quality of learning & teaching and research in higher education can be prominently improved with the adoption of ICTs [50]. ICTs have had and will still have a huge impact on the education practices in considerable years to come in developing countries [36].

The extant literature identifies the significant role of ICTs in stimulating Innovation, especially in developing nations and suggests means to create aiding frameworks in the implementation of green computing that help the green economy with regards to eco-friendly growth and eradication of poverty [13]. The connection between ICTs and nature is complex, as ICTs can play both positive and negative jobs. It is accepted that numerous IT applications positively affect diminishing environmental pollution and carbon discharge, for example, e-business, smart grids, green buildings, digitization, virtual merchandise/services and artificial intelligence-based transport systems [21]. On the other side, it is seen that both manufacturing and utilization of ICTs are the sources of excessive energy use, and this records for 2 percent of total carbon outflows [39]. In any case, the use of ICTs will keep on rising, prompting more harms except if proper strategies are implemented to decrease or wipe out the corresponding ecological hazards.

### *B. Green Computing & Sustainability*

The term Green computing or Green IT alludes to the successful application of ICT to such an extent that their negative effect on the environment is minimum [27], [7], [44]. It is a part of an extensive corporate supportability program that objectives achieving the triple essential apprehension of securing the economy, climate and social framework [16], [37]. The advantages that

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accumulate from the act of green computing contain a reduction in the overall consumption of energy, cost minimization, alleviation of ecological impact and carbon impression, effectiveness in the use and execution of frameworks, and improved space use [30]. Green Computing life-cycle approach provides a comprehensive guideline for dealing with the environmental impact of IT effectively. These guidelines are categorized into four groups viz Green Design, Green Usage, Green Manufacturing and Green Disposal. If implemented completely, organizations would accomplish absolute natural maintainability from the IT side and embrace greener IT all through the lifecycle [30]. The recommended acts of green computing consolidate dematerialization of IT-based tools and services by giving substitutes that have extremely low carbon impression [19]; refurbishing, reusing and recycling old equipment; environment-friendly cooling systems for data centres; and usage of standard parts to give supports of consistency and green-stamps on made things [41]. Green IT design strategy, appropriation, activities and practices in associations have recently risen to a unique research centre in the Information Systems field [11]. The impacts of Green IT can be either straightforwardly seems to be possibly substantial by minimizing negative effects of Green IT on nature or backhanded utilizing information systems(IS) to help different strategic approaches in diminishing their destructive effects on the earth [23].

### *C. Green Computing Adoption*

The extant literature shows that a lack of awareness is the greatest hindrance for embracing green computing practices and solutions in the IT business and that this condition of unawareness is a reason for stress as it impacts a nation's monetary recuperation through decreased energy consumption and prevention of inefficient spending. Most students and staff at Universities have less knowledge of the everyday energy usage of PCs. With the objective for them to practice and actualize Green Computing, they should get familiar with Green IT strategies. Nowadays, colleges from all around the world are saving energy and use direct ways to deal with assistance in lessening carbon impression [34]. It is observed that the organizations where green practices are followed have shown significant improvement in energy conservation and reduces the power usage of ICTs [2]. Countries like the U.S., Hongkong, India, part of Europe and the U.K. have already initiated several green educational programs in schools and universities to educate the young generation [31].

Gulf countries too have understood the importance of green computing and have started or about to start the adoption of it in many sectors. The education segment is absolutely no exception. They are investing heavily in projects that are sustainable environmentally and economically. In the recent years, Saudi Arabia has invested more than $50 billion on renewable energy projects to cut down the burden on oil use and to transform towards green power to meet growing energy demand [9]. According to a study conducted in Gulf Universities, reveals that there are three important factors affecting the adoption of green practices among student viz. organizational, environmental and technological factor [5]. The organizational factor incorporates lack of awareness, relatively favourable position, the executives support and the availability of resources is the primary hindrance for the adoption of green practices. The general motivations for the adoption of green practices in organizations have been identified in the literature and categories as economic, ethical and regulatory [35]. Top management support, greening of organizational culture and the alignment between strategic intent and green IT adoption will positively impact organizational green IT adoption resulting in sustainable competitive advantage [17]. Another finding proposed that the constant online intuitive forum doesn't just invigorate the enthusiasm of an individual in environment-related issues, yet besides brings issues to light about the

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effect his ICT related exercises have on the Mother Nature [33].

In developing countries, the investment in ICT in higher education is constantly increasing which can be seen in the increased level of ICT adoption in the stakeholders. However, the extant literature reveals that the awareness of sustainable use of IT seems to be meagre. Research in Zambia shows that even though there is an elevated level of ICT utilization in the HEIs, the degree of green computing awareness was essentially moderate and the degree of green computing adoption was low [28]. Another research carried out at Bulacan State University reported that there is a significant difference both on the level of knowledge and level of readiness while there is no substantial difference on the level of initiatives on the perspectives of the respondents from the college of industrial technology and other colleges and satellite campuses [8]. Another significant factor towards green computing adoption is the mentality towards it by the stakeholders alongside their apparent green computing conduct over genuine green computing behaviour. [1]. In Malaysia, limited knowledge about green computing is identified as the primary hurdle for the adoption of green computing [4]. The limited awareness about green computing practices is identified as the major hurdle by other universities operating in developing countries [28],[1],[38],[4],[18]. It is important to know that the level of awareness among students from ICT related programs is found to be higher than the students from another program of study [18].

From the extant literature, it is observed that limited research has been done about green computing in the gulf countries, especially in Saudi Arabia. Studies eyeing especially at students' green computing knowledge are very few [4],[15]. More research of this nature that dive into awareness level and knowledge of varied university individuals are truly necessary to provide starting point information for green strategic activities [1]. The necessity for green computing adoption research is continually developing as developing nations committed to the draining environment constant to rise, in this way, there is a more noteworthy size of prospects to explore Green IT as one of the strategic methodologies in hoisting attention to students at a beginning period of learning and other members worried about the methodology. Future research could explore this unanswered research question to choose the association among perceived and objective knowledge of Green IT among stakeholders. There is a lack of understanding of the role of the field of study and gender in the level of Green IT awareness [22]. Research in green computing has primarily centred on arrangements and practices for the IT business and organizations and has to a great extent dismissed the significance of inspecting what end-users, particularly students in colleges and universities, think about green behaviour and whether they follow green compliant practices.

For the aforesaid grounds, the knowledge, practices, attitude and initiatives of the higher education towards a green transformation is put to question and driven this study to find it out in a Saudi public university. Specifically, the study aimed to discover the correlation between subjective and objective knowledge followed by the effect of gender and program of study on it. Finally, the research will suggest the initiatives towards a green shift of education.

## III. RESEARCH METHODOLOGY

The theoretical outline of the study was founded on the research investigating the green computing subjective knowledge of stakeholders concerning their attitude towards the green environment [3]. The researchers postulated that the idea of green computing awareness is a multidimensional paradigm encompassing of the knowledge of green computing terminology, use of ICTs and electronic waste management. This research is based on the life-cycle approach to Green computing that encompasses several features including buying, reusing, refurbishing and recycling [30].

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In this research, the students' awareness of green computing is measured in three ways, knowledge, practices and attitude & intentions towards green computing. The knowledge head includes perceived and objective knowledge related to green computing. Perceived or subjective knowledge refers to one's feeling or experience-based of self-assessment of knowing the subject [47]. It is the amount to which individual reports about one's knowing a certain phenomenon [3]. It is debated that one's level of perceived knowledge, particularly learned through direct understanding, affects their green ecological conduct [26]. Objective knowledge denotes as what an individual really and accurately think about green computing concepts. The green computing practices refer to the practices followed by an individual during the use of ICTs and the attitude & intention towards the adoption of green computing.

### *A. Survey Instrument*

A self-administered questionnaire was used as an instrument for data collection. It was based on the authenticated measurement found in the literature on green computing adoption studies [4], [18]. The questionnaire is distributed into six sections: (A)respondents characteristic, (B) ICT literacy of the respondent was measured through four objective questions, (C) perceived knowledge is measured through nine Likert items on a five-point scale going from Very High to None, (D) Objective Knowledge is estimated through seven Yes-No-I Don't know items on different Green Computing jargon, (E) Green practices adopted by the respondent is surveyed through twelve Likert things on a five-point scale going from Never to Always and (F) attitude and intentions of the respondent towards the adoption of green practices is measured by six Likert items on a five-point scale extending from Strongly Disagree to Strongly Agree. The questionnaire was validated by expert and Cronbach's alpha consistency test is completed utilizing the Statistical Package for Social Science (SPSS) 24. The value for interior consistency (α) for the subjective knowledge was 0.93, for objective knowledge was 0.81, for green computing practices was 0.84 and for attitude and intentions was 0.94.

### *B. Sample Selection*

The survey involves 218 students from four campuses of the College of Business Administration at Jazan University in Saudi Arabia. The sample was randomly selected from its six bachelor programs namely business administration, banking & finance, accounting, management information systems, e-commerce & marketing, and law. A total of 140 male and 78 female students took part in the survey. The ICT literacy reported by the respondent in the university is quite high. 90 percent of students reported that they are using the computer for more than 3 years. 70 percent of students reported that they are using computer and internet for more than 4 hours daily and are quite familiar with the ICT usage (Figure 1). Majority of the total respondent was from third and fourth Year which means that they have spent enough time in the university and quite familiar with the use of ICT(Figure 2).

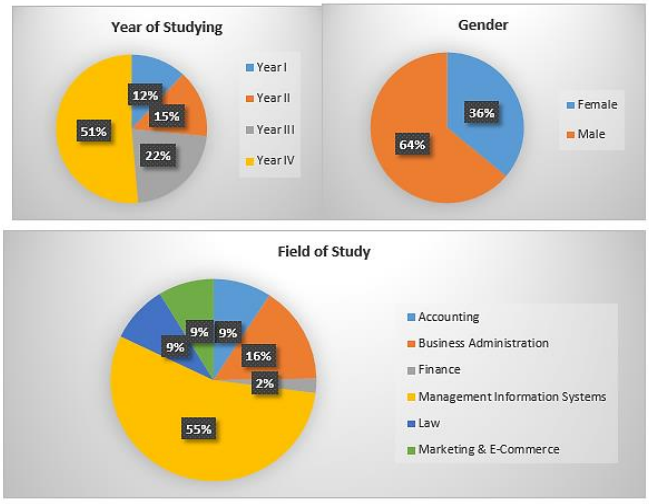


**Figure-1 Demographic Details**

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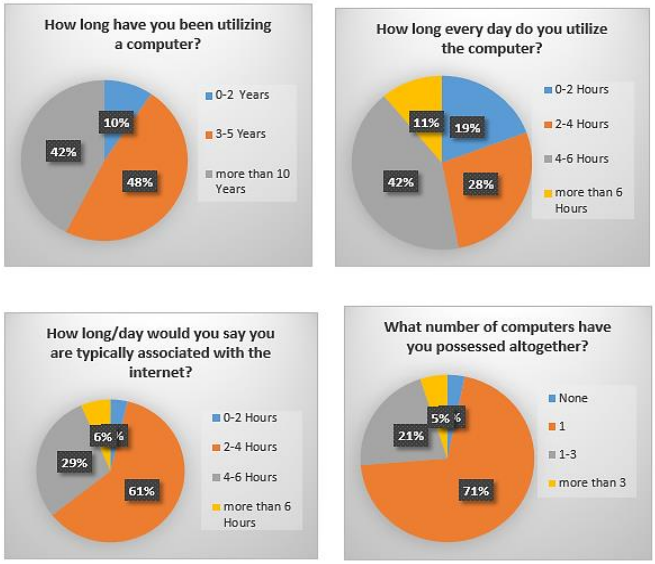


**Figure-2 Computer Literacy among students**

As shown in the figure 1, 51 percent of respondents were from final year followed by 22 percent from the third year. Among the total respondents, 64 percent were male and 36 percent were female students. Majority of respondents i.e. 55 percent who opt for the survey are observed to be from the MIS program whereas the remaining 45 percent of respondents were from Non-IT programs.

As shown in the figure 2, 90 percent of respondents reported that they are using the computer in their educational and personal activities for more 3 years. The use of computer in studies engaged them for more than 4 hours every day is reported by 70 percent respondents whereas more than 61 percent reported that they spent 2 to 4 hours on the internet. More than 90 percent of respondents were having at least 1 computer for the educational purpose. So, it can be concluded that the overall awareness of the use of ICT in education among the respondents was fairly high and hence the sample selected for the further research on green computing awareness is found to be appropriate.

### *C. Data Collection Procedure*

The students filled the surveys through direct, email and online Google survey forms. Emails, text messages and social media were used to motivate students for greater participation. The online survey was conveyed to a pool of students arbitrarily distinguished from the student enrollment database provided by the registration unit of the university. There were 218 usable responses received constituting an acceptable response rate of 72%. The data analysis was carried out using SPSS version 24. Based on the research objectives, the tools used for analysis includes a combination of descriptive statistics (percentage and frequency analysis), consistency test by Chronbach's alpha, Independent Sample T-Test and Bivariate Correlation.

## IV. RESULT

The discussion on the result is divided into three parts: (1) perceived knowledge outcome, (2) objective knowledge outcome, (3) Green Computing practices and (4) attitude & intentions outcome.

### *A. Perceived Knowledge Outcome*

Perceived or subjective knowledge indications to the level of knowledge based on self-assessment or experience, was estimated through nine (09) Likert items on a 5-point scale going to vary from Very High to None. Figure 3 shows the outcome of the students' responses:

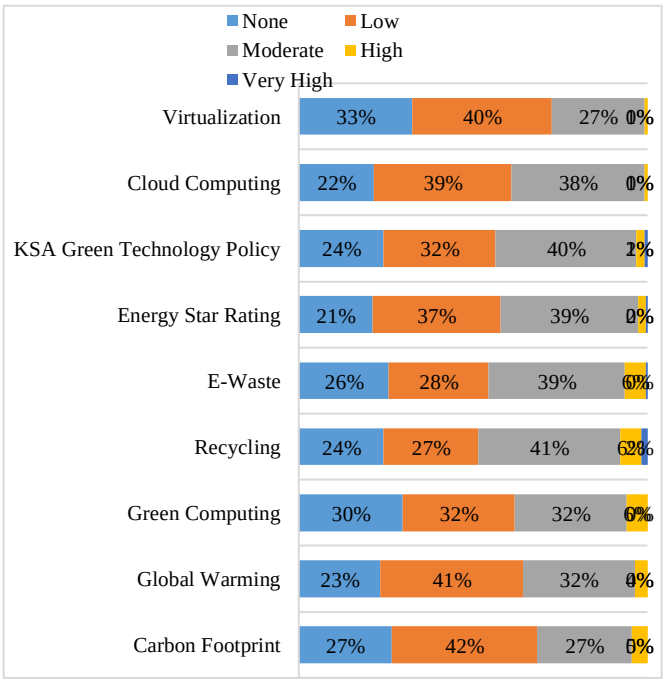


**Figure-3 Student's Perceived Knowledge of Green Computing ( N=218)**

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It is intriguing to realize that an exceptionally high level of respondents has Low or No knowledge of the green computing vocabulary. For the term virtualization, 73 percent reported that they low or no knowledge of it followed by carbon footprint (68 percent), global warming (64 percent), green computing (62 percent) and so on. The respondents reported having moderate or high knowledge for the terms recycling (49 percent), e-waste (45 percent), KSA green technology policy (44 percent) and so on. It is observed that the perceived knowledge for any of the stated green computing terms is not more than 50 percent. Hence, it is concluded that the perceived knowledge of green computing terms was very poor among the respondents.

Further, to check the relationship of gender and program of study on students' perceived knowledge, the responses were summated and subject to Independent Sample T-Test. The results are shown in Table 1.

**Table-1 Relationship of Gender and Field of Study on Students Perceived Knowledge: A summary of Independent Sample t-Test**

| | Respondents | N | Mean | Std. Deviation | T | p-value |
|---|---|---|---|---|---|---|
| Gender (N=215) | Female | 78 | 1.9972 | .76729 | -2.888 | .004* |
| | Male | 137 | 2.2814 | .64873 | | |
| Program | Non-ICT | 97 | 1.9404 | .75786 | 4.758 | 0.001* |
| (N=217) | ICT | 120 | 2.3759 | .59044 | | |

(*significant at p<0.05)

The male respondents detailed marginally more significant level of green computing knowledge (Mean=2.28, Std. Dev. = 0.64) than females (Mean=1.99, Std. Dev. = 0.767) by 0.29. This difference is statistically noteworthy [ t(218) = -2.888, p=0.004]. Cohen's effect size of d=0.40 is significant as it surpasses the edge of d=0.20 for small effect size. The Students from ICT program revealed marginally more significant level of knowledge(Mean=2.38, Std. Dev. = 0.59) than Non-ICT students (Mean=1.94, Std. Dev. = 0.75) by 0.44. The difference was found statistically critical [ t(218) = 4.758, p=0.001]. The Cohen's effect size (d=0.63) is noteworthy as it surpasses the limit (d=0.20) for small effect size.

### *B. Objective Knowledge Outcome*

Objective knowledge alludes as what students really and accurately know about green IT, was estimated through seven (07) Yes-No-I Don't know responses on statements based on green computing. Figure 4 shows the aftereffect of the students' reactions:

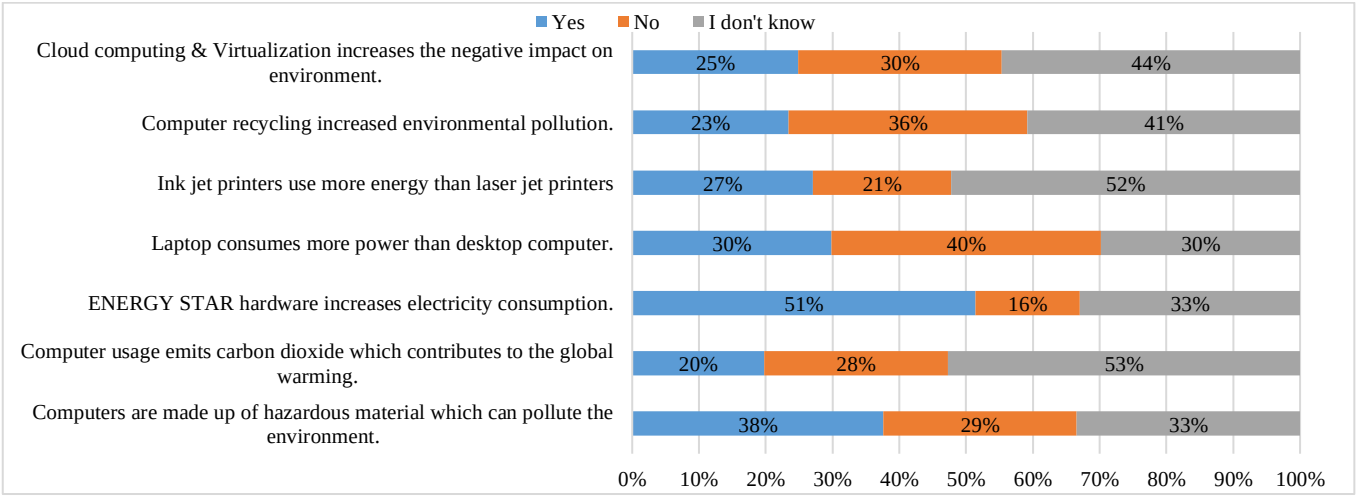


**Figure-4 Student's Objective Knowledge of Green Computing ( N=218)**

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From the above figure, it is observed that many respondents reported that they don't know about the green computing statements posed to them. The statements which were not known to most of the respondents were "Computer usage emits carbon dioxide which contributes to global warming" (53 percent), "Inkjet printers use more energy than laser jet printers" (52 percent), and "Cloud computing & Virtualization increases the negative impact on the environment" (44 percent). For the statement "Laptop consumes more power than a desktop computer" and "Computer recycling increases environmental pollution", a high number of respondents (40 percent and 36 percent respectively) responses were "No". It shows that they were aware of it. On the contrary, for the statements "ENERGY STAR hardware increases electricity consumption" and "Computers are made up of hazardous material which can pollute the environment" high number of respondents (51 percent and 38 percent respectively) responses were "Yes". 28 percent of respondents reported "No" to the statement "Computer usage emits carbon dioxide which contributes to global warming". It shows that their knowledge is wrong about these statements.

Based on the research objective, the impact of gender and program of study on students' objective knowledge was tested using Independent Sample T-Test. The results are shown in Table 2.

**Table-2 Relationship of Gender and Field of Study on Students Objective Knowledge: A summary of Independent Sample t-test**

| | Respondents | N | Mean | Std. Deviation | T | p-value |
|---|---|---|---|---|---|---|
| Gender | Female | 78 | 2.0466 | .49402 | 2.111 | 0.001 |
| (N=216) | Male | 138 | 2.2143 | .66320 | | |
| Program | Non-ICT | 98 | 2.0417 | .52722 | 1.852 | 0.232 |
| (N=218) | ICT | 120 | 2.1837 | .60435 | | |

(*significant at $p<0.05$)

The males reported slightly higher level of green computing objective knowledge (Mean=2.21, Std. Dev. = 0.66) than females (Mean=2.04, Std. Dev. = 0.49) by 0.17. The difference was statistically significant [ t(218) = 2.111, p=0.001]. Cohen's effect size of d=0.30 is practically important as it exceeds the threshold of d=0.20 for small effect size. The Students from MIS program reported slightly higher level of knowledge (Mean=2.18, Std. Dev. = 0.60) than Non-MIS students (Mean=2.04, Std. Dev. = 0.53) by 0.44. The difference was found statistically significant [ t(218) = 4.758, p=0.001]. The Cohen's effect size (d=0.26) is practically significant as it exceeds the threshold (d=0.20) for small effect size.

### *C. Green Computing Practices*

Section E contained twelve (12) Likert type items related to green computing practices followed by the university student. Figure 5 shows the result of the students' responses:

As shown in the Below figure, the majority of the respondents reported that they hardly follow any green computing practices. The practices least followed by the respondents were "Take or send your computer to a manufacturer's or retailer's recycling program" (67 percent) followed by the practice "Donate the computer to a not-for-profit organization, school, or person who needs it" (62 percent) and "Enable the energy management settings on your computer" (61 percent). However, a high number of respondents (67 percent) reported that they rarely or never follow the practice of "The old computers and peripheral not in use are thrown away in the trash for disposal". For the practice "The sleep mode reduces energy consumption", 50 percent of respondents reported that they sometimes or always follow it. Another interesting information is the use of practice "Send e-mail or transfer data files through the internet" sometimes to always followed by 49 percent of the

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respondents. As shown in the figure, the majority of the practices are rarely or never practised by the respondents. Hence, it is concluded that the low level of awareness among students is the primary hindrance for embracing green computing.

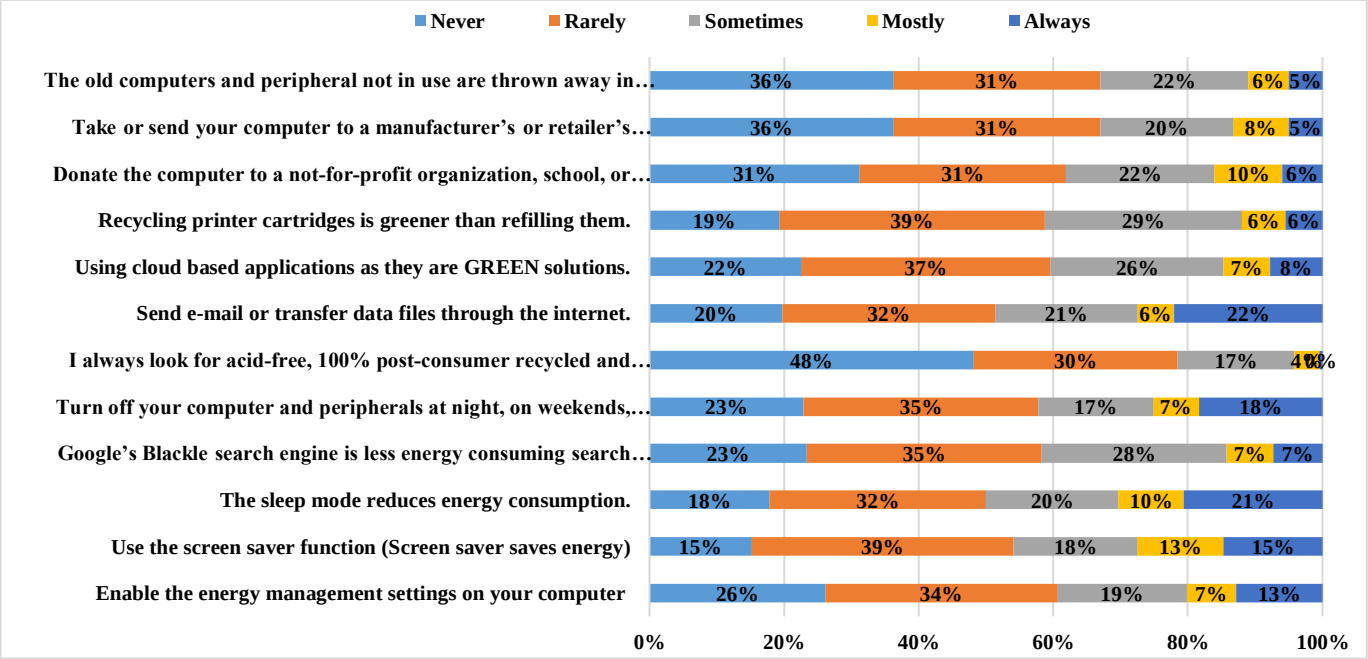


**Figure 5 Green Computing Practices ( N=218)**

Further, the relationship between gender and program of study on students' Green Computing Practices was tested using Independent Sample T-Test. The results are shown in Table 3.

**Table-3 Relationship of Gender and Field of Study on students' Green Computing Practices: A summary of Independent Sample t-Test**

| | Respondents | N | Mean | Std. Deviation | T | p-value |
|---|---|---|---|---|---|---|
| Gender | Female | 78 | 2.4925 | .67849 | 1.17 | 0.275 |
| (N=216) | Male | 138 | 2.3684 | .78205 | | |
| Program | Non-ICT | 98 | 2.1675 | .64422 | -4.647 | 0.041 |
| (N=218) | ICT | 120 | 2.6174 | .76120 | | |

(*significant at p<0.05)

The female respondents reported slightly higher level of use of green computing practices (Mean=2.49, Std. Dev. = 0.67) than males (Mean=2.36, Std. Dev. = 0.78) by 0.13. The difference was statistically significant [ t(216) = 1.17, p=0.275]. Cohen's effect size of d=1.60 is practically important as it exceeds the threshold of d=0.20 for small effect size. The Students from MIS reported higher level of adoption of green computing practices (Mean=2.62, Std. Dev. = 0.76) than Non-MIS students (Mean=2.16, Std. Dev. = 0.64) by 0.46. The difference was found statistically significant [ t(218) = -4.64, p=0.041]. The Cohen's effect size (d=0.67) is practically significant as it exceeds the threshold (d=0.20) for small effect size.

### *D. Attitude & Intentions Outcome*

Section F contained six (06) Likert type items related to the student's attitude and intentions towards the acceptance of green computing. Figure 6 shows the result of the students' responses:

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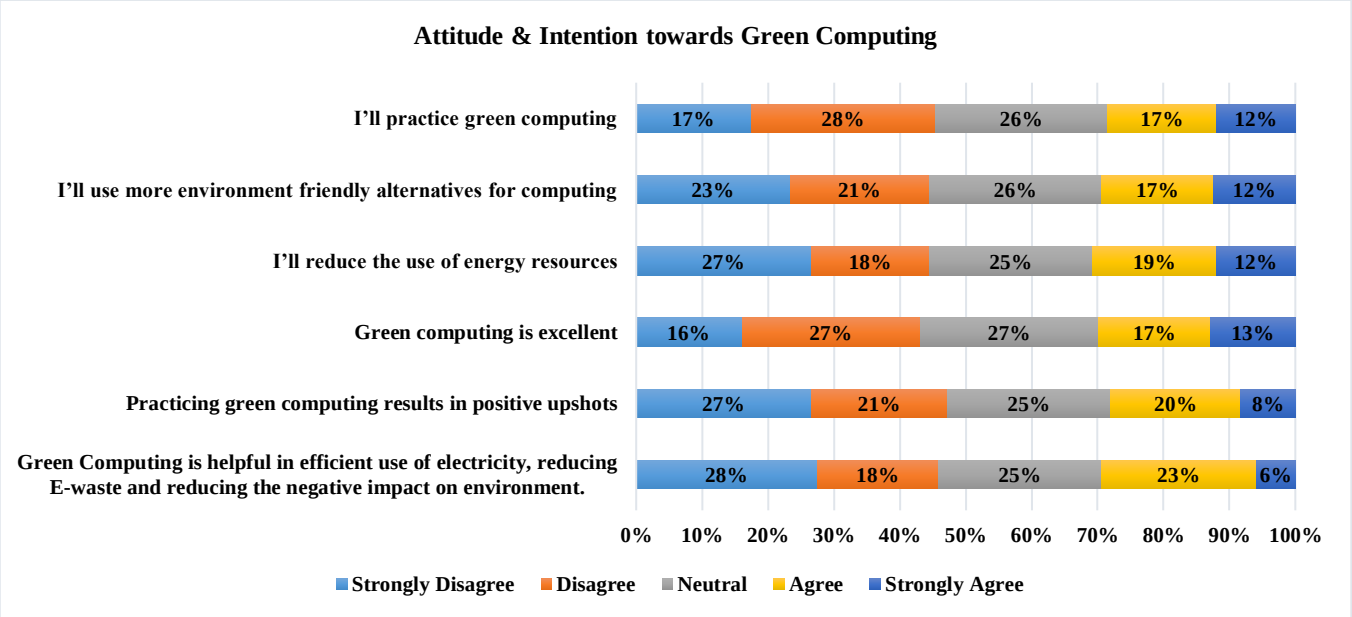


**Figure-6 Attitude & Intention ( N=218)**

The result shows that very few (30 percent) students willing to practice green computing or environment-friendly computing or reduce the use of energy resources. The remaining were not sure or don't want to use it. Very few (less than 30 percent) students attitude towards green computing was reported on the positive side. The results clearly show that the students were not sure or disagree with the adoption of green practices.

Further, the impact of gender and program of study on students' Attitudes and Intentions was tested using Independent Sample T-Test. The results are shown in Table 4.

**Table-4 Relationship of Gender and Field of Study on students' Attitude and Intention towards Green Computing: A summary of Independent Sample t-Test**

| | Respondents | N | Mean | Std. Deviation | T | p-value |
|---|---|---|---|---|---|---|
| Gender | Female | 78 | 2.9808 | 1.08012 | 2.56 | 0.065 |
| (N=216) | Male | 138 | 2.5725 | 1.15118 | | |
| Program | Non-ICT | 98 | 2.7602 | 1.03076 | 0.495 | 0.029 |
| (N=218) | ICT | 120 | 2.8833 | 1.22444 | | |

(*significant at $p<0.05$)

## V. DISCUSSION

This research is an underlying endeavour to decide the awareness level, attitude and practices of university students in green computing in Saudi Arabia, a case of developing nation. The low levels of green computing awareness among university students right now steady with discoveries from past investigations led far and wide [1],[3],[7],[18],[28],[38]. A lower level of green computing practices among students affirms the absence of comprehension about its repercussions on the environment. It is reported that a very high number of students are using the computer and internet in the University Learning and research. More than 90 percent of respondents owned at least 1 computer for educational and personal use. Therefore, it can be concluded that the overall awareness of the utilization of ICT in education among the respondents was genuinely high. With such raised degrees of usage joined with the low degrees of green computing awareness especially concerning energy use of computing devices, universities will consistently confront the test of

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high power bills, and thus, ending up being significant sources of carbon emissions.

It is interesting to realize that an exceptionally high number of respondents have Low or No perceived knowledge of most of the green computing vocabulary. Among the least known terms reported by the respondents were “virtualization”, “carbon footprint”, “global warming”, and “green computing”. A larger part of the respondents reported that their objective knowledge about green computing is low. A considerable lot of respondents didn't even know about it. The statements which were not known to the greater part of the respondents were "Computer usage emits carbon dioxide which contributes to global warming", "Inkjet printers use more energy than laser jet printers”, and “Cloud computing & Virtualization increases the negative impact on the environment”. While testing the experience with green computing practices, it is observed that a large number of respondents hardly follow most of it. The green practices reported least followed by the respondents were “Take or send your computer to a manufacturer’s or retailer’s recycling program” followed by the practice “Donate the computer to a not-for-profit organization, school, or person who needs it”, and “Enable the energy management settings on your computer”. Finally, while testing the intentions and attitude of respondents towards the adoption of green, it is observed that very few students willing to practice “green computing or environment-friendly computing” or “reduce the use of energy resources”. The students were not sure or disagree with the motivation for the embracing of green practices.

The students with high perceived knowledge also have good objective knowledge about green computing concepts. The attitude and intentions for the adoption of green computing practices directly related to knowledge. Therefore, a very low number of students show a willingness to embrace green computing practices. It is proposed that an individual's experience with a situation has a significantly more effect on their conduct [26]. It is likewise placed that perceived knowledge is partly because of one's direct experience [3][49]. Subsequently, students' low degrees of green computing knowledge across both levels of computing behaviour can be credited to the unsatisfactory green practices in the nation and at the college specifically.

While testing the effect of gender on green computing, the male respondents reported a marginally more significant level of green computing perceived and objective knowledge compare to female respondents. The female respondents reported a slightly higher level of use of green computing practices and a higher level of intention and attitude towards the acceptance of green computing. The effect of the program of study on the level of awareness reported that the respondents from the MIS program show an overall higher level of awareness compares to Non-MIS students.

## VI. CONCLUSION & FUTURE WORK

This research has featured the state of green computing knowledge and practices followed by university students, especially in the Saudi higher education setting. The finding indicates that students across all levels of programs of studies are not well educated about green computing practices. The findings have uncovered a significant reality that computer experience has a stimulus on green computing awareness. The embracing of ICT among university students is swiftly growing. The dependence on computer and internet is unavoidable to surge carbon emission and global warming, a lot of which brought about by the condition of their ignorance about sustainable green computing. There is a need for holistic green computing programs across Saudi universities to educate students about sustainable green usage of ICT. The university administration needs to show full commitment to the implementation of green computing in the campus. Universities could find on the possibilities of green computing to be a piece of advanced education educational program

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in outcome-based instruction framework. They should create ecologically feasible computing strategies that endorse power-saving, cost-cutting, waste minimizing, and optimum usage of significant resources. This initiative could be the most effective way to improve green computing awareness among the stakeholders thereby reducing the campus-wide carbon footprint and thereby the issue of global warming.

The investigation has featured the condition of awareness about green computing among university students in Saudi Arabia. Future examinations can utilize this perception and further extend it to suit various settings and research targets. Subsequently, it could be utilized as a contribution to persistent improvement and advancement activities.

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