International Journal of Environmental Sciences
Vol. 9 No. 2 (July-December, 2023)

http://www.theaspd.com/ijes.php

Environmentally Sustainable Green Computing Practices among Indian youth

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Received: 09th July 2023
Revised: 27th November 2023
Accepted: 06nd December 2023

Abstract: Technological advancements have made electronics and electric devices an integral part of our lives. E-waste generation has also grown in recent years as more electronic devices are being produced each year. To attain sustainable development, adopting eco-friendly practices like Green Computing is crucial. Primary research was conducted to examine the awareness and adoption of green computing by Indian youths in various stages including acquisition, usage, and disposal. The study discovered that buying patterns and usage methods play a substantial part in promoting green computing habits while the act of disposing e-waste has an insignificant impact. Additionally, several factors affect people's approach toward environmental computing practices. It is recommended according to the findings that organizations prioritise on creating and implementing green computing strategies, with an emphasis on encouraging sustainable e-waste disposal procedures.

Keywords: Green computing; green usage; e-waste; e-waste disposal; environmentally sustainable practices.

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1. Introduction

Electronics and electric devices have become increasingly important elements of our daily lives as technology has advanced, leading to a significant impact on the environment (Kaushik & Bagga, 2020). The use of electronic devices has grown over time, resulting in an increased power consumption which contributes to the carbon footprint. This is because electronic gadgets require energy from non-renewable sources such as fossil fuels which emit greenhouse gases during their extraction and burning. (Ali, et al., 2019). In the recent times, consumers preferences are greatly affected by changes in fashion or trend i.e., fast fashion which pose a challenge in terms of purchasing and usage behaviour of the consumers.

In addition, with the escalating production of electronic devices annually, the amount of e-waste generated has skyrocketed in recent times (Egeonu & Herat, 2016). Numerous tonnes of this hazardous waste are being carelessly dumped into landfills daily without proper treatment measures. This lackadaisical attitude towards handling e-waste is significantly contributing to environmental degradation and endangering our planet's sustainability. According to Global e-waste monitor 2020, after China and the US, India is the third-largest producer of e-waste in the world, generating over 3.2 million tonnes of waste each year (Forti, et al., 2020), and an unspecified amount of e-waste is imported from other nations across the world.

In India, the gathering and treatment of e-waste have expanded fourfold in the last four years, but 95% of it is disposed of unlawfully by the informal sector (Dutta & Goel, 2019). Toxic contaminants can be released into the environment as a result of recycling in the informal sector. Several hazardous substances in e-waste endanger human health and the environment.

To tackle this problem, corporations are endeavouring to integrate more eco-friendly goods in their product line and diminish the utilization of non-renewable resources during production. Moreover, companies are augmenting the number of facilities designated for e-waste disposal to allow individuals to dispose of outdated electronic gadgets securely. This is where the notion of "green computing" comes into play as to attain sustainable development, we need to implement eco-friendly measures (Bagla, Trivedi & Bagga, 2022).

The environmentally sustainable and eco-friendly use of computers and their components is known as "green computing." To put it another way, this can be defined as designing, building, manufacturing, utilising, and discarding of computing systems in a way that reduces their environmental impact. Green computing offers several benefits, including lower carbon footprints, resource and energy conservation, and cost savings (Ribeiro, et al., 2021). Additionally, employees who work for companies that employ green computing practices are more motivated and effective at their jobs than those who work for companies that do not (Bagga & Khanna, 2014). The fact that green computing cuts expenses and ultimately saves businesses a lot of money, in the long run, is another significant benefit. Furthermore, green computing practices enable consumer to have good quality products which safe is for their health and the environment (Marques, et al., 2019).

Energy-saving and environmentally beneficial goods may result from green electronics design and production (Akman, 2015). Implementing it can lower carbon dioxide emissions and contribute to environmental protection. The environmental harm caused by electronic devices can be lessened by using green production processes. When electrical equipment and devices are purchased, used, and disposed of sustainably, greenhouse gas emissions are reduced, which helps to lessen the impact of climate change. It's also crucial to keep in mind that by adopting energy-efficient appliances and products, we not only contribute to environmental preservation but also save our utility costs.

As a consumer, our behaviour towards green computing practices can have a significant impact on the environment. There are various factors that guide the behaviour of consumers towards green computing practices such as the awareness of environmental concerns (Sakkthivel, 2016) and demand for sustainable products as well as external factors (Anthony, et al., 2019) such as government policies and regulations that promote environmentally friendly practices. Consumer activities affect how much energy is used and how much e-waste is produced, which can have a severe influence on the environment if green computing practices are not implemented. Therefore, we need to adopt green computing practices because if we do not, we will not be able to protect the environment for future generations.

The objective of the paper is to study the awareness and perspective of Indian youth towards green computing and to study the behaviour of youth towards different stages of green computing practices i.e., acquisition/purchase, usage and disposal.

2. Review of literature

2.1 Green Computing Adoption

Green computing, also referred to as green IT or sustainable computing, is a growing area of study that seeks to harness the power of computer infrastructure and associated hardware/software systems while mitigating their negative impact on the environment (Asadi, et al., 2018). It is defined as "the study and practice of designing, manufacturing, using, and disposing of information systems efficiently and effectively, with zero or minimal impact on the environment" (Murugesan, 2008, pp. 24-33). As cutting-edge technologies such as mobile devices, social media platforms and cloud-based services continue to be present in many aspects of global business operations nowadays (Sofia, 2015), it has become increasingly imperative for organizations across industries to prioritize eco-friendly practices to promote sustainability (Jayaprakash & Pillai, 2020). While there are certainly both positive and negative effects stemming from this growing dependence on IT tools within organizational settings, understanding how best to balance these impacts with environmental concerns remains an important academic pursuit for scholars today (Ali, et al., 2019). The reduction of paperwork and use of environmentally friendly materials are examples of the good influence; however, energy use, emissions associated to IT, and e-waste are examples of the negative impact (Shah, et al., 2019). Thus, it is more important than ever to adopt green computing practises as technology use rises and its consequences on the environment become more visible.

There are various ways for people to adopt green computing practises and make a positive difference for the environment. It is also observed that consumers' attitudes towards such procedures will determine if green information technology (GIT) is successfully implemented (Ojo, et al., 2019). There are several fundamental concepts that can greatly influence the attitudes of individuals towards adopting environmentally-friendly information technology. One such concept is the notion of social influence which emerges as a critical personal aspect dictating consumer behaviour in this domain. The impact of SI on consumers' attitude has proved to be significant, with various studies documenting its role as an influential factor in shaping consumer perceptions related to eco-consciousness and sustainable practices while using technologies. In social psychology theories, SI is represented by subjective norms in a variety of well-known human behaviour (Aboelmaged & Mouakket, 2021).

Additionally, adopting green information technology (GIT) is crucial for ensuring organisations' environmental performance through responsible IT device production, consumption, use, and disposal so that the organisation may reduce its energy use and carbon emissions, improving the environment in the process (Ojo & Fauzi, 2020). Creating awareness by providing knowledge is also important for adoption of green computing and for this purpose students must get instruction on environmental issues and green IT practises at universities and schools that intend to improve their environmental performance through the rise of their environmental concern (Dezdar, 2017).

2.2 Purchase and usage behaviour

The adoption of green buying habits involves a comprehensive approach towards electronics procurement that prioritizes environmental sustainability. This entails meticulous evaluation of the ecological footprint of each product throughout its lifecycle, spanning from production to disposal. To promote pro-environmental IT practices at an individual level, measures such as activating power management features in IT equipment, procuring recycled materials-based devices, selecting energy-efficient central processing units (CPUs), servers and peripherals, conserving resources by reducing consumption and turning off computers when not in use can be implemented. By expanding our academic understanding on this subject matter, we can effectively contribute to global efforts for conservation and sustainable development (Dalvi-Esfahani, et al., 2020). Also, looking for energy-saving products, such as purchasing gadgets with an Energy Star rating, which shows that they consume less energy and release less greenhouse gases (Joumaa & Kadry, 2012). It's very important to take the product's lifespan into account. Additionally, buying refurbished or used technology can reduce waste and the need for new manufacturing (Perera, et al., 2018).

By adopting these informed choices, we may decrease the impact on the environment and encourage the development of environmentally friendly practises in the electronics industry. Moreover, the most frequent locations where devices are acquired are retailers, there awareness and communication efforts could be carried out to make consumer purchasing behaviour environmentally sustainable (Martinho, et al., 2017).

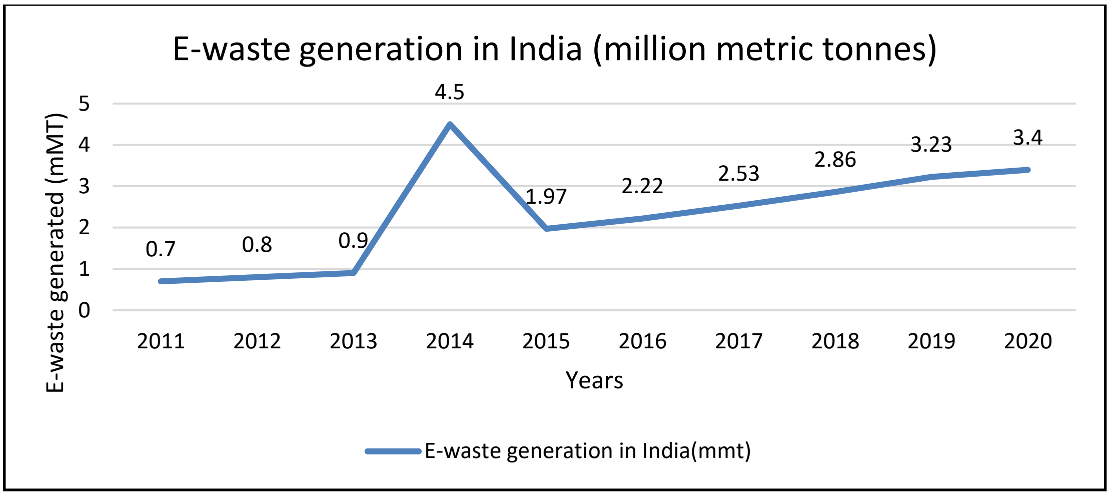
2.3 E-waste disposal

Electronic waste, also referred to as e-waste, refers to outdated electrical or electronic equipment. It is also frequently referred to as end-of-life (EOL) electronics or waste electrical and electronic equipment (WEEE). Refrigerators and freezers, air conditioners, lamps, cell phones, microwaves, televisions, personal recorders, all consumer electronics, and computers are all examples of industrial waste. Elements discovered in this form of trash include lead, strontium, mercury, cadmium, nickel, arsenic, copper, zinc, barium, beryllium, all types of plastics, aluminium, gold, silver, platinum, hazardous compounds from consumables, and diphenyl polybrominated ethers (Fayaz, et al., 2022). These hazardous substances included in e-waste pose risks to both the environment and human health (Islam, et al., 2021). In terms of generating electronic waste, India ranks high among the top producers worldwide, having produced as much as 3.2 million metric tonnes in the year 2019. In India, e-waste is classified as standard municipal waste, and no special attention is paid by the local and national governments to operations related to its collection, handling, disassembly, and recycling (Borthakur, 2016). Knowing that the country lacks the infrastructure required for the secure handling and disposal of e-waste, there are risks to public health and environmental degradation. In India, a significant amount of electronic garbage is recycled carelessly, frequently by unskilled workers in unsanitary conditions, exposing them to hazardous substances including lead, mercury, and cadmium (Sengupta, et al., 2022) .

Managing e-waste is a crucial global issue given how prevalent electronic devices are in modern life and how plenty of them are being used (Agrawal & Mittal, 2017). High-tech products, like cell phones, have a limited lifecycle due to their short lifespan (Uddin, et al., 2021). New models are introduced by manufacturers to follow the most recent popular trend in appearance design and the highest level of technology. Consumers typically replace outdated versions that are still usable with newer models as they become available (Ahluwalia & Nema, 2009). Due to these firms' aggressive marketing tactics and consumers' tendency to toss things away, there is a serious e-waste problem. Therefore, consumer awareness and adoption about the harmful effects of e-waste is a key factor in managing this issue (Dias, et al., 2021).

Figure 1 shows India's generation of the electronic waste in million metric tonnes from the years 2011-2020 according to the CSE report 2020, CPCB report and Global e-waste monitor report. It shows that in 2014 there was sharp rise in e-waste generation which declined in the following year but since then it is constantly rising (Biswas & Singh, 2020).

Recycling, refurbishing, and donating are the important e-waste disposal methods that is required to be applied for reducing the damage that electronic devices make to the environment and the health of people (Kaushik & Herat, 2020). Urban mining practices is also crucial and have become international trends in recent years as precious metals and raw material like gold, silver, and copper can be recovered by disassembling electrical devices and equipment into its component pieces (Tsai, 2019). Additionally, by applying this sustainable method you could reduce the quantity of hazardous substances released into the atmosphere as well as the quantity of electronic waste dumped in landfills. Also, there are various factors that guide the recycling behaviour among the consumer which should be studied in depth (Kianpour, et al., 2017). On the other side, refurbishing requires modernising or repairing electrical components that are still functional which helps in increasing the life span of the devices (Laitala, et al., 2021).Thus, for the protection of the environment and future of the planet, adding up landfill with e-waste dumps should be avoided as much as possible. Consumer practices of discarding electronics with trend should also be controlled as to minimize the generation of e-waste. To solve the e-waste disposal issue, ethical and sustainable behaviour including repair, reuse and recycling of electronic items must be encouraged. Governments may influence manufacturers to make more recyclable and sustainable products and have a big impact on how electronic trash is disposed off.



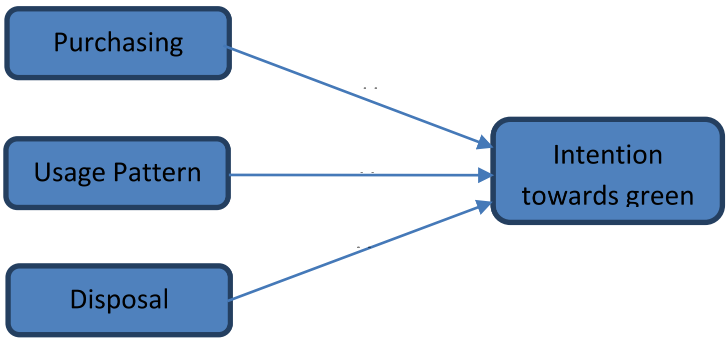
Source:-: CSE, 2020, CPCB report and Global e-waste monitor report

Figure 1 E-waste generation in India

3. Research Methodology

The study is based on the primary data which was collected from Indian youth from the age group 15 to 35 years. With the help of an online survey data was collected in form of a questionnaire made with Likert scale (5-point) ranging from 'strongly disagree' to 'strongly agree' which is one of the most basic and widely used psychometric tools in educational and social science research (Joshi, et al., 2015). The questionnaire consist of 3 sections comprises of total 27 questions which covered the questions related to the demographics of the consumers including age, gender, occupation and education along with the 5-point Likert scale questions based on the statements reflecting purchasing behaviour, usage pattern and disposal methods of consumers.The sample size comprises 172 Indian youth who responded to the questionnaire has been taken and the descriptive research design has been used in conducting the research. In this study it helped to examine the relationship between different variables.Research Hypothesis are:

- H1: There is no significant effect of purchasing behaviour on the intention toward green computing.
- H2: There is no significant effect of usage pattern on the intention toward green computing.
- H3: There is no significant effect of the disposal method on the intention toward green computing.



For the statistical analysis of the primary data, the IBM SPSS Statistic 25 software has been used. In order to measure the internal consistency, reliability test has been conducted using the Cronbach Alpha.Multinominal logistic regression analysis has been performed to predict the categorical dependent variable.Factor analysis has been performed using to explore the underlying dimensions that explain the relationships between the multiple variables/items.One-way ANOVA test has been used to examine if variations, or different levels of demographics factor have a measurable effect on a dependent variable.

4. Findings

Demographic Characteristics of the respondents

The study collected and assessed the responses of 172 Indian youth through the survey. There were 109 female and 63 male participants. The majority of the respondents were between the age group of 21-25 (67.4%), which aligns with the age of most university students. Thus, it shows the majority of the student respondent in the data. The highest educational qualification of the majority of the respondents was a bachelor's degree (48.8%), followed by post-graduation (41.9 %).

Table 1 Demographic profile of the respondents

Demographics		Frequency	Percentage
Gender	Female	109	63%
	Male	63	37%
	Others	0	0%
Age	15-20	30	17%
	21-25	116	68%
	25-30	16	9 %
	31-35	10	5 %
Education	School	14	8 %
	Graduation	84	49 %
	Post Graduation	72	42 %
	Others	2	1%
Occupation	Student	129	75%
	Salaried Person	36	21%
	Business	2	1%
	Others	5	3%

5. Data analysis and findings

Awareness among respondent

The survey shows that most of the respondents are well aware of the harmful effects of electronics devices and how their activities can have an adverse impact on the environment. It has been observed most of the respondents are university students of both graduation and post-graduation, as a result, findings indicate that 58.7% of the respondents have knowledge about utilizing computers and their resources in an environmentally friendly manner, which is commonly referred to as green computing practices. Out of 101 aware respondents, 57.4% respondents said to be practicing green computing. There can be various factors which are responsible behind their adoption of sustainable methods such as environmental concern, organizational pressure, monetary gain etc. which are analysed in the study.

Reliability of research constructs

Reliability test is done to evaluate the consistency or stability of a measure across various rates or objects, such as a survey or questionnaire. The Statistical Package for the Social Science (IBM SPSS Statistics 25) was used to determine Cronbach's alpha (α) for ensuring the reliability of the constructs of scale. It is regarded as an indicator of scale reliability. The result shows value of the Cronbach's Alpha equals to 0.778, this value suggests that the scale used by the researcher has very good internal consistency for the factors as a reliability coefficient of .70 or higher is considered acceptable (George & Mallery, 2003). The reliability test was conducted to determine the dependability of respondents' responses to the study instruments. In survey-based research, the respondents' honest and unambiguous responses are crucial for determining the validity of the data that must be measured.

Multinomial Logistic Regression

Given one or more independent variables, multinomial logistic regression (often referred to simply as "multinomial regression") predicts a nominal dependent variable Kwak, C., & Clayton-Matthews, A. (2002). In this study, dependent variable is intention towards green computing and three independent variables are green purchase, green usage and green disposal. The "Final" row (Table 2) shows if all of the model's coefficients are zero (i.e., whether any of the coefficients are statistically significant). The p = .000<0.05, indicates that the entire model statistically significantly predicts the dependent variable better than the intercept-only model alone. The Pseudo R-Square measures are Cox and Snell (0.161), Nagelkerke's (0.182) and McFadden(0.059). The model accounts for 8.1% to 18.2% of the variance.

The result, as shown in Table 3, shows which of your independent variables are statistically significant. It can be seen that purchase and usage are statistically significant because p = .008 and p = .033 respectively. On the other hand, the disposal is not statistically significant because p = .583 which is much higher than 0.05 level of significance.

Table 2 Model Fitting Information

	Model Fitting Criteria	Likelihood Ratio Tests		
Model	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	360.448			
Final	330.277	30.171	6	.000

Source: Authors' computation using primary data

Table 3 Likelihood Ratio Tests				
	Model Fitting Criteria	Likelihood Ratio Tests		
Effect	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	351.882	21.606	2	.000
Purchase	340.042	9.765	2	.008
Disposal	331.357	1.080	2	.583
Usage	337.102	6.825	2	.033

Source: Authors' computation using primary data

Factor analysis

Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

The KMO evaluates the strength of the relationship between variables. It determines sample adequacy, which must be greater than 0.5 in order for a satisfactory factor analysis to proceed.

Values of KMO that are close to 0.5 are not considered satisfactory, whereas those falling between the ranges of 0.5-0.7 represent an average score. If a value lies within the range of 0.7-0.8, it is acceptable and if it falls between 0.8-09 then it is great, and lastly (above 0.9) is considered (Kaiser & Rice, 1974). Accordingly, based on our results which indicate a KMO value of =0738, we can conclude that its level surpasses the 0.5 value i.e., it’s an acceptable value.

Another indicator of the strength of the relationship between variables is Bartlett's test. The null hypothesis that the correlation matrix is an identity matrix is tested here. The Bartlett's test of sphericity is also found to be significant. As p-value = 0.000 is less than 0.05. Thus, null hypothesis is rejected. This means that correlation matrix is not an identity matrix.

Table 4 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.374	23.019	23.019	4.374	23.019	23.019	3.134	16.493	16.493
2	3.060	16.104	39.123	3.060	16.104	39.123	2.627	13.826	30.319
3	1.453	7.648	46.772	1.453	7.648	46.772	2.183	11.492	41.811
4	1.288	6.777	53.549	1.288	6.777	53.549	1.878	9.883	51.694
5	1.176	6.188	59.737	1.176	6.188	59.737	1.528	8.043	59.737
6	.986	5.192	64.929						

Source: Authors' computation using primary data

Total variance explained

Eigenvalue actually denotes the number of extracted factors, the sum of which should be equal to the number of items that are subjected to factor analysis. The presence of eigenvalues larger than one is required to identify the number of components or factors specified by selected variables. Results shows that for 1stcomponent the value is 4.374 > 1, 2ndcomponent is 3.060 > 1, 3rdcomponent is 1.453 > 1, 4th component is 1.288 and 5th component is 1.176 > 1. Thus, the stated set of 19 variables represents 5 components.

Rotated component matrix

7	.959	5.049	69.978

	Component				
Purchase when required (P1)		.426	.497		
Purchase due to trend (P2)			.672		
Frequently change (U1)			.687		
Buy environmentally safe products (P3)	.778				
Buy green electronics even if it's expensive (P4)	.786				
Buy second hand (P5)		.467			
Minimize the electricity consumption (U2)	.572				
Use in environmentally friendly manner (U3)	.576			.423	
Repair devices (U4)				.756	
Dispose off in the garbage bin or truck (D1)					.591
Exchange old devices (D2)				.731	
Sell off in second hand market (D3)			-.697		
Give away to kabadiwalas (D4)		.700			
Give away for charity (D5)		.452			
Participate in Electronic Recycling Programs (D6)	.667				
Disposal for money.(D7)		.630			
Disposal for organizational pressure (D8)		.675			
Disposal for environmental protection (D9)	.698				
Dispose off small electrical appliances in dustbin (D10)					.750

Table 5: Rotated Component Matrix

The rotated component matrix, often known as the loadings, is the primary result of principal components analysis. It includes estimates of the correlations between each of the variables and the estimated components. It helps you to determine what the components represent.

- Component 1 represents the behaviour of the consumers who are environmentally concern and responsible whether in terms of purchase, usage or disposal. Their activities are performed in such a way that it leads to minimum environmental damage.
- Component 2 represents the behaviour of the consumers who are influenced by an external factor like money, organizational pressure and their activities are associated with monetary gains.
- Component 3 represents the behaviour of the consumers who are influenced by the trends and their activities are associated with fast fashion. They preferences for electronic devices changes frequently due to which they are likely to sell off their devices in second hand market.
- Component 4 represents the repair and return behaviour of the consumers which is associated with repairing or replacing products that have reached their functional limit, or exchanging them for new ones.

- Component 5 represents the behaviour of the consumers who are environmentally irresponsible and their activities leads the e-waste to end up in landfill.

One-way ANOVA

ANOVA (Analysis of Variance) is a statistical method for data analysis that examines differences between multiple (more than two) population means. To determine whether variations or different levels of a factor have a noticeable impact on a dependent variable, one-way ANOVA is performed.The demographics factors – gender, age, education level and occupation has been used as an independent factor for conducting One-way ANOVA test.

Table 7 One- way ANOVA test

	F	Sig.
Gender	.350	.555
Age	4.019	.009
Occupation	1.402	.244
Educational level	5.274	.002

Source: Authors' computation using primary data

In the above output table, we can observe that the significance value for gender is 0.555 (i.e., p = .555), which is much greater than 0.05. and, therefore, we'll accept the null hypothesis i.e., there is not a statistically significant difference in the mean of the intention towards green computing between the different genders.

For the age, it was observed that the significance value is 0.009 (p = .009), which is lower than 0.05. and, therefore, we'll reject the null hypothesis i.e., there is a statistically significant difference in the mean of the intention towards green computing between the different age groups.

For the occupation, it was observed that the significance value is 0.009 (p = .009), which is lower than 0.05. and, therefore, we'll accept the null hypothesis i.e., there is not a statistically significant difference in the mean of the intention towards green computing between the different occupations.

For the educational level, it was observed that the significance value is 0.002 (p = .002), which is lower than 0.05. and, therefore, we'll reject the null hypothesis i.e., there is a statistically significant difference in the mean of the intention towards green computing between the different educational level of the Indian youth.

6. Conclusion

In today's fast-paced world, it is crucial to adopt green computing and environmental sustainable practices. As technology continues to advance rapidly, we must ensure that we use it responsibly without compromising the environment. It is imperative to take a holistic approach towards minimizing its impact on our surroundings.

The research aimed to study the awareness and analyses the behaviour towards green computing practices. For this purpose, the primary data has been obtained from 172 Indian youth which has revealed several findings.

The results showed that the awareness among Indian youth about the harmful effects of electronic appliances and green computing practices is relatively good and the aware consumer intent to practice green computing. The study reveals that purchase behaviour and usage pattern have a significant impact on the intention toward green computing. Whereas, the e-waste disposal practices used by the consumers does not have a significant impact as methods used by them are not environmentally sustainable (Bagga & Kapoor, 2022). Therefore, there is a need for greater emphasis on sustainable e-waste disposal practices. It was also observed that the behaviour towards green computing is influenced by a range of factors, including concern for the environment, external factors like money, fast fashion, and return and repair intention. Moreover, it was found that , there is a statistically significant difference in the mean of the intention towards green computing between the different age groups and education level of the respondents.

In light of these findings, it is suggested that businesses put a priority on creating and implementing green computing strategies, with an emphasis on encouraging sustainable e-waste disposal procedures. Campaigns to raise awareness and educational programmes geared at Indian youth can accomplish this.

Furthermore, it is critical to understand that usage habits and purchasing habits are key factors in determining the success of green computing initiatives. As a result, it's critical to promote sustainable consumption habits and provide incentives for eco-friendly decisions. Overall, the study's conclusions have significant implications for the growth of sustainable IT practises in India and can be used as a reference by enterprises and authorities who want to encourage young Indians to act sustainably.

7. Limitations of the study and Further research

The present study is based on the data provided by a sample size of 172 Indian youth. In order to obtain more comprehensive results and for scope of further studies, it would be beneficial to expand the sample size and include individuals from various sections of society residing in different geographical locations. Additionally, employing alternative methods for collecting data such as conducting interviews can provide deeper insights into this subject matter.

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