Digital Carbon Footprints in Academia: Rethinking Sustainable Digital Practices

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Abstract

Sudden digitalization of tertiary education in COVID-19 re-shaped teaching, learning, and governing but created unsuspecting environmental expenses in terms of digital carbon footprints. Digital practices (email, cloud storage, video conferencing, online teaching) among faculty members, students, and administrative staff were studied. A mixed-method design involving survey data (N=200) was used in conjunction with focus groups and interviews. Email was the most employed medium (mean = 4.26), followed by cloud storage (4.0) and online platforms (3.96). Approximately 40% of the participants dealt with 11–30 emails per day, and 25% dealt with 31–50 emails. Personal awareness of digital carbon footprints was moderate (60%), with only 15% demonstrating high awareness. Green practices involved deleting unwanted emails/files (42%) and cutting down video calls (17%). Chi-square analyses indicated role had a significant impact on willingness to embrace sustainable practices (χ^2 (3) =12.35, p=0.006), but gender did not. Logistic regression also established email usage (OR=1.57, p=0.02) and awareness (OR=1.82, p=0.01) as predictors. The results emphasize the importance of institutional awareness campaigns, energy-efficient infrastructure, and policies supporting sustainable digital practices within academia.

Keywords: Digital carbon footprint, higher education, sustainable digital practices, email usage, cloud storage, video conferencing, awareness, behavioral drivers

Introduction

The instant digitalization of higher learning had revolutionized instruction, education, research, and administrative practices. Especially in the post-pandemic context, universities heavily depended on online educational platforms, cloud storage facilities, virtual libraries, video calls, and email correspondences to enhance educational interaction. The technologies

improved accessibility, flexibility, and efficiency to enable frictionless communication among students, teachers, and personnel across locations (Selwyn, 2020; Hodges et al., 2020). Virtual classrooms, electronic submissions of assignments, and shared research platforms had less reliance on physical infrastructure, thus widening the reach of education globally.

These electronic practices did, however, involve tremendous and often neglected environmental costs. Data center usage, cloud storage, and digital communication took up power, leading to greenhouse gas (GHG) emissions, which in turn created the digital carbon footprint (Belkhir & Elmeligi, 2018). Whereas higher education institutions had long concentrated on reducing emissions from physical infrastructure, the indirect environmental impacts of digital use were as yet underexamined. The global digital economy produced around 3–4% of total GHG emissions, roughly on a par with the aviation sector (Andrae & Edler, 2015). In universities, intensive emailing, video conferencing, cloud storage, and big research databases expanded this footprint, yet knowledge and uptake of sustainable methods were confined.

The shift to digital platforms had already been spurred by institutional and societal pressures, including the COVID-19 pandemic, which required widespread online administrative work and remote learning (Bao, 2020). Although this shift exhibited institutional resilience, it also increased digital energy consumption substantially (Masanet et al., 2020). Even with expanding sustainability efforts within higher education—such as energy-saving buildings and waste management initiatives (Lozano et al., 2013)—the environmental consequences of digital practices remained mostly out of sight.

Understanding digital carbon emissions involved taking into account structural and behavioural determinants. Institutional policies, ICT infrastructure, and technological tool availability shaped digital engagement, while habit, awareness, and behavioural bias decided usage behaviour. Behaviours like massive emailing, duplicated cloud storage, and repeated high-definition video calls consumed more energy without tangible payback. Behavioural research revealed that users tended to under-estimate indirect environmental impacts by virtue of present bias and missing feedback mechanisms (Thaler & Sunstein, 2008; Parguel et al., 2011). Consequently, encouraging sustainable digital practices required both technological fixes—like energy-efficient servers—and behavioural changes, including information campaigns and policy advice.

Although significant, research on digital carbon footprints in academic settings had been scarce. Most existing studies addressed ICT practices at the corporate level, with the gaps being what influenced academic sustainability behaviours from digital habits, awareness, and institutional roles (Belkhir & Elmeligi, 2018; Masanet et al., 2020). Universities, as large consumers of energy as well as knowledge disseminators, had an obligation to promote environmentally friendly practices among the academic and student community.

This research filled these voids by analyzing academic digital practices, calculating corresponding carbon footprints, and exploring awareness and behavioural inclinations. By combining quantitative insights into use with qualitative understanding of attitudes and perceptions, the research offered a comprehensive perspective on digital sustainability. Finally, it sought to inform institutional policy interventions and strategies aimed at lowering emissions and creating sustainable digital uses within higher education.

Objectives

- To measure the prevalence and patterns of digital practices within academic settings.
- To analyze behavioural and awareness patterns associated with digital practices in academia
- To analyze faculty and student awareness levels regarding digital emissions and sustainable digital practices.

Scope and Methodology

This research paper considered digital practices at higher education institutions, surveying the prevalence, patterns, and environmental footprint of practices like email use, cloud storage, video conferencing, and online instruction. It explored awareness levels and behavioural inclinations among faculty, students, and administrative personnel, considering what drove sustainable digital participation. A mixed-method design was employed, combining quantitative data from guided questionnaires and ICT use reports with qualitative information gathered through focus group discussions and interviews. Descriptive statistics were used to examine digital behaviour patterns, whereas inferential methods such as chi-square tests and logistic regression analysis were used to test associations among demographic variables, awareness levels, and intentions to pursue sustainable practices. This approach allowed for a qualitative analysis of the structural and behavioural factors influencing digital carbon emissions within academia.

Literature Review

Earlier research has also identified the significant contribution of Information and Communication Technologies (ICT) towards global greenhouse gas emissions (Andrae & Edler, 2015; Belkhir & Elmeligi, 2018). The concern is largely attributed to the fast-growing demand for data transmission, storage, and processing. For example, Masanet et al. (2020) re-calculated previous projections of data center energy consumption and demonstrated that although gains in efficiency have retarded growth in energy, the ongoing growth of digital services puts increasingly greater pressure on energy systems. Within higher education, digitalization has been extensively researched but frequently from access and pedagogical perspectives, not sustainability. Selwyn (2020) examined the wider uptake of digital technologies in higher education, whereas Hodges et al. (2020) made a critical distinction between "emergency remote teaching" implemented during emergencies such as the COVID-19 pandemic and more consciously planned types of online courses. Such contributions point to the pedagogical and institutional dimensions of digital uptake but do not go so far as to estimate their environmental impacts.

At the same time, the sustainability literature emphasizes universities' special obligation to set the example in managing environmental crises. Lozano et al. (2013) contended that universities are not just knowledge creation hubs but also experimentation laboratories for sustainable development, and thus their digital decisions are especially determining. And lastly, behavioral economics insights inject one further dimension of complexity: Thaler and Sunstein's (2008) choice architecture work and Parguel et al.'s (2011) exploration of consumer underestimation of indirect effects indicate that individuals even scholars have a tendency to ignore the unseen environmental price of digital actions like streaming, emailing, or cloud storage. This work synthesizes these threads by exploring academic digital practices both through sustainability and behavioral economics frames in order to demonstrate how universal digital routines in universities are implicated in, but can also help combat, environmental effects.

Result and Discussion

The research revealed that higher levels of digital participation were observed among academic stakeholders, specifically the faculty, but the environmental awareness of these practices was moderate. Institutional roles seemed to have affected behavior with the faculty

showing the highest intentions to adopt sustainable digital practices, while there was no impact of gender on the level of awareness. Behavioural factors, particularly the use of email and general awareness, were identified as prime drivers of willingness to adopt environmentally sustainable digital behaviour, indicating that application and awareness were more essential than demographic factors. These results indicated that university-based promotion of sustainable digital behaviour needed both behavioural interventions, e.g., awareness raising and institutional policy, and technical solutions, e.g., low-energy equipment and cloud storage optimization. Universities were instrumental in spearheading policies and initiatives that directed faculty, students, and personnel towards minimizing digital carbon footprints, thus creating a greener academic environment.

The survey found that most of the respondents were in age groups 26–35 years (30%) and 36–45 years (29%), suggesting that the sample was mostly mid-career instructors and postgraduate pupils. Females comprised a narrow majority (54%) compared to males (46%), and the majority of the participants were instructors (71.5%), followed by pupils (17.5%), administrative personnel (6.5%), and others (4.5%). With regard to digital use, email came out as the most utilized tool (weighted score 4.26), followed by cloud storage (4.0), online teaching platforms (3.96), video conferencing (3.88), social media (3.52), and USB/data sharing (3.0). Email usage on a daily basis revealed that 40% of the respondents sent or received 11–30 emails, and 25% managed 31–50 emails. Weekly video conferencing was moderate, with 40% spending 2–5 hours in meetings or online classes, and 40% uploaded or stored 1–5 GB of data per week in cloud storage.

Digital carbon footprint awareness was moderate, with 60% of participants aware of the term and both video conferencing (35%) and cloud storage (30%) being most associated with high energy consumption. Level of awareness between participants was mixed, with 30% moderately aware, 25% aware, and 15% very aware of the environmental consequence of their online behaviors. In terms of sustainable behavior, 60% said they had implemented steps to minimize their digital footprint, such as deleting excess emails and files (42%), employing energy-efficient gadgets (25%), reducing video calls or switching to audio calls (17%), and not duplicating storage (13%). Additionally, 60% said they would implement sustainable digital practices if supported by their institution, 25% were indifferent, and 15% did not want to.

Table 1: Chi-Square Test Results for the Association Between Demographic Variables and Digital Practices

Variables	χ^2 Value	df	p-value
Role × Willingness to adopt	12.35	3	0.006
Gender × Awareness	1.25	1	0.26

Source: estimated value

The chi-square statistic reveals that an individual's role has a significant effect on their desire to uptake digital practices ($\chi^2(3) = 12.35$, $p = 0.006$), reflecting differences between students, faculty, and staff. There is, however, no significant association between gender and awareness of digital practices ($\chi^2(1) = 1.25$, $p = 0.26$), reflecting comparable levels of awareness among male and female participants.

Table 2: Logistic Regression Results for Predictors of Willingness to Adopt Digital Practices

Predictor	Coefficient (β)	Odds Ratio	p-value
Email usage	0.45	1.57	0.02*
Video conferencing	0.30	1.35	0.08
Cloud storage	0.25	1.28	0.10
Awareness level	0.60	1.82	0.01*
Age	-0.05	0.95	0.35
Gender (Male=1)	0.10	1.11	0.60
Role (Faculty=1)	0.20	1.22	0.15

Source: estimated value

Logistic regression analysis reveals that email use ($\beta = 0.45$, OR = 1.57, $p = 0.02$) and awareness level ($\beta = 0.60$, OR = 1.82, $p = 0.01$) are significant indicators of digital practice adoption willingness, with greater email use and increased awareness increasing the odds of willingness considerably. Other predictors, such as video conferencing ($\beta = 0.30$, OR = 1.35, $p = 0.08$), cloud storage ($\beta = 0.25$, OR = 1.28, $p = 0.10$), age ($\beta = -0.05$, OR = 0.95, $p = 0.35$), gender ($\beta = 0.10$, OR = 1.11, $p = 0.60$), and role ($\beta = 0.20$, OR = 1.22, $p = 0.15$), although

indicating positive or negative trends, are not statistically significant at the 5% level. This implies that of the factors taken into consideration, pragmatic digital engagement and consciousness are the prime motivators of readiness to use digital practices.

Limitations and Research Gaps

The sample was predominantly comprised of faculty, constraining generalizability by role. Data were based on self-reports, potentially introducing bias. Calculations of emissions were not performed directly as CO_2 equivalents, and the scope did not capture other digital practices like LMS platforms and research simulations. Future studies need to use objective digital energy metrics, sample diversely, and increase institutional coverage.

Conclusion

This research identifies the environmental price of digitalization of universities, demonstrating awareness and email intensity are the most influential drivers of adopter willingness for sustainable use of digital systems. Staff were most ready, highlighting institutional roles as crucial to implement these practices. Recommendations in policy formulations are awareness campaigns, green IT policies, guidelines for digital usage, and the establishment of energy-efficient infrastructure. Universities can minimize digital carbon footprints and integrate sustainability into academic culture through combining behavior and technological interventions.

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