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The Dark Side of Technology-Enabled Teaching:

Impact of Technostress on Student Performance

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ABSTRACT

This study validates an instrument used to measure technostress creators, technostress support mechanisms, and their negative impact on students' satisfaction and performance. A research model is developed based on the stimulus, organism, and response model to analyse the mediating effect of technostress creators and understand how technostress inhibitors influence students' satisfaction and their performance. A group of 206 students from India pursuing higher education were selected as a sample to validate this model. Technostress creators act as a mediator between technostress inhibitors and students' satisfaction and their performance, while technostress inhibitors positively influence student satisfaction and performance indirectly. Insights from this study will enable higher education institutions to identify the students who are finding technology-based education problematic and help preserve their wellbeing by following supportive strategies to reduce stress and enhance the students' active participation in technology-based education.

KEYWORDS

Student Performance, Technology-Enabled Teaching, Technostress, Technostress Inhibitors

INTRODUCTION

A crucial part of dealing with COVID-19 is to ensure that people have convenient access to services with minimum disruptions. In order to limit loss of life and spread of the coronavirus, the government of India announced a stringent lockdown on March 21, 2020. One of the many impacts of the lockdown was that it speeded up the adoption of emerging technologies in all possible fields. Industries were forced to boost both quality and delivery time of their services and this held good for the education sector as well. Technology-enabled teaching makes learning more productive and competitive, enhancing both technical skills and knowledge (Battaglino et al., 2012; Meyer & McNeal, 2011). However, acceptance of new technology requires a change in mindset of students, educationalists, policymakers, and government agencies. Many studies suggest that given proper infrastructure and skilled educators, technology-enabled teaching will boost the academic performance of students (Battaglino et al., 2012; Biagi & Loi, 2013; Genlott & Grönlund, 2016; Jena, 2015; Meyer & McNeal, 2011; Pagani et al., 2016) but many Indian educational institutions are not ready for technology-

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enabled classrooms or online classes. Overall, the quality of education will be measured not only by the quality of the faculty but also by the quality of the infrastructure for Information, Communication and Technology (ICT) and the capacity to use the technology (Biagi & Loi, 2013; De Witte & Rogge, 2014; Pagani et al., 2016; Tolani-Brown et al., 2010).

A sudden change in the teaching and learning process can affect the satisfaction of the students and their performance. The University Grants Commission (UGC), an Indian higher education regulator, has asked institutions of higher education to continue their teaching-learning process using technology-enabled teaching tools. UGC has provided guidelines to the universities that stipulate that educators should be trained in such a way that they complete about 25% of the syllabus through online teaching. It has also requested the higher educational institutions to establish virtual classrooms and video conferencing infrastructure and train all teaching staff in using the technology. UGC further suggests that institutions of higher education adopt mentor-mentee counselling through a dedicated platform to provide students with appropriate guidance (UGC, 2020). However, the guidelines provided by UGC focus on the perspectives of institutions for higher education and educators and fail to address the students' acceptance of technology-enabled teaching and/or the issues they face related to technology-enabled teaching. Many Indian institutions have accelerated the adoption of technologies to deliver classes, but digital literacy is almost non-existent among over 90% of India's population (ICT Academy, 2020). Issues such as slow Internet connectivity, lack of telecom infrastructure, online system affordability, availability of personal systems and software will make digital teaching more complex. These reasons could create stress for students of generation Z, even if they are highly exposed to technology (Jena, 2015; Jena & Mahanti, 2014; Shu et al., 2011; X. Wang et al., 2020).

Earlier studies have focused on technostress creators, the support mechanisms to reduce technostress, and its negative impact on outcomes (Shu et al., 2011; Tarafdar et al., 2011, 2015; Wang et al., 2005). All these studies were done in developed countries and primarily focused on the organisational context. However, there is lack of evidence to measure levels of technostress based on technostress creators, support mechanisms and technostress impacts from the perspective of students completing their higher education in developing countries, even though a few studies have been done from the academicians' perspective (Jena, 2015; Jena & Mahanti, 2014). Therefore, this study aims to fill this gap by validating an instrument to measure technostress creators, technostress support mechanisms and the negative impact of technostress on students' satisfaction and performance. This study aims to provide better insights to identify students who find technology-enabled teaching problematic and, at the same time, help the higher education institutions preserve their wellbeing by following supportive strategies that reduce stress and enhance their active participation in technology-enabled teaching.

LITERATURE REVIEW

Technostress

Technostress has been defined as an incapability of the human mind to cope with new technological interventions (Ayyagari et al., 2011). This incapability to adapt to a new technology starts with an uneasy feeling that arises due to various reasons, such as limited knowledge about technical functions, low technical literacy, and limited technical support; and leads to anxiety and stress. This anxiety, if not taken care of, will lead to various psychological and physical problems. Arnetz & Wiholm (1997) used this word and tried to explain the psychological and mental state of people struggling to adopt technology in their work. Johansson-Hidén et al. (2003) described this term as ICT stressor, which affects a person's mental health and their productivity. ICT has been introduced in organisations to reduce human anxiety and tension; however, it has sometimes been seen to create insecurity and uncertainty, leading to a feeling of inadequacy and stress (Arnetz & Wiholm, 1997; Ragu-Nathan et al., 2008; Tarafdar et al., 2010, 2015). End-user productivity is compromised by continuously evolving technology, applications, and techniques which, in turn, lead to overload, fear of becoming obsolete, and dissatisfaction with work (Ragu-Nathan et al., 2008; Sainfort, 1990; Tarafdar et al., 2010, 2015). Research has discussed various forms of technostress, known as techno-anxiety (Lee et al., 2016; Salanova et al., 2013; Sellberg & Susi, 2014), techno-addiction (Dhir et al., 2018; Rozgonjuk et al., 2018) and techno-strain (Salanova et al., 2013).

Technostress Inhibitor

Organisations need to develop well-built technology-coping strategies to adapt to ICT changes, otherwise these stress creators will lead to technostress (Christian et al., 2020; Ragu-Nathan et al., 2008; Tarafdar et al., 2015). These coping mechanisms usually consist of ICT training and technical infrastructure to integrate these new technologies smoothly into the system. These supportive coping strategies are termed as technostress inhibitors (Ragu-Nathan et al., 2008; Tarafdar et al., 2014, 2015). To counter the negative effect of this fast-changing technological world, these inhibitors have to be used strategically. The literature suggests three technostress inhibitors, namely literacy facilitation, technical support provision, and involvement facilitation (Fuglseth & Sørebø, 2014; Li et al., 2020; Tarafdar et al., 2019). Technical support provisions are described as knowledge and support infrastructure available in the organisation to handhold the people at the time of scarcity of technical knowledge. This support can reduce the negative after-effects associated with ICT usage. This technical assistance helps to familiarize the students with new technology and resolve their problems and challenges (Chandra et al., 2019; Srivastava et al., 2015; Tarafdar et al., 2011). An organisation can extend literacy facilitation by providing different employees with technical development programs to improve their technical skills and knowledge (Fuglseth & Sørebø, 2014; Safahieh & Asemi, 2010). To avoid further delay in the process, an organisation should emphasise and try to inculcate a culture of teamwork (Shu et al., 2011; Tu et al., 2005; Wang et al., 2005). Tu et al. (2005) conclude that when an organisation provides a high level of technical assistance to its employees, it will benefit from increased productivity. Moreover, a regular technology development program would encourage employees to use more technology (Shu et al., 2011). The level of technostress can be lowered to a great extent if the employee perceives that an organisation is giving sufficient administrative assistance (Burke, 2009; Koo & Wati, 2011). The problem of technostress was reported mostly where employees were forced to use technology without their consultation and training. (Kupersmith, 1992; Liu, 2012; Poole & Denny, 2001; Tseng, 2015; Vyhmeister et al., 2006). Involvement facilitation is described as the extent to which an individual is involved in the process of planning and implementing the technology. With this involvement, the end-user would feel well informed about future actions like why, how, when, and the potential effect of new technology implementation.

Al-Qallaf (2006) found that an absence of a regular technical skill development program and sufficient training; lack of network infrastructure and involvement at the time of planning and implementing the ICT; an inadequate workforce for assisting people at the time of a breakdown; and an ever- increasing demand, and information overload were some of the many reasons leading to technostress. When literature focus is analysed, lack of formal training and user acceptance are seen to rank high as factors leading to technostress (Al-Fudail & Mellar, 2008; Buarki et al., 2011; Jena, 2015; Kupersmith, 1992; Qi, 2019; Tarafdar et al., 2010, 2019).

In general terms, extant studies have shown that technostress inhibitors may minimise the negative effects of technostress creators on the work output of people. Simple access to help desk and technical support to fix end-user encounter issues in their work, for example, may relieve stressed feelings and boost performance (Jena, 2015; Ragu-Nathan et al., 2008; Tarafdar et al., 2011). Also, the involvement of university teachers in the planning, implementation, assessment, and refinement phases of ICT integration in higher education may diminish their technostress (Brooks & Califf, 2017; Li et al., 2020). Informed by previous studies on technostress inhibitors and creators, technostress inhibitors can boost end-user competence in the use of ICT in their work, improve their work engagement and ultimately increase their work output.

Technostress Creators

The survival of any organisation is dependent on its existence on various digital platforms, such as web and mobile applications, social media, and other collaborative applications to manage different stakeholders (Ollo-López & Aramendía-Muneta, 2012; Yunis et al., 2012). Various research papers talk about different platforms and how their excessive usage and dependence lead to technostress (Hung et al., 2015; Lee et al., 2016; Ragu-Nathan et al., 2008; Salo et al., 2019).

In organisational research, the job performance of workers is a significant factor that defines whether individual companies outperform others. The value of job performance also extends to higher education environments where students, funding support, and reputations have become increasingly competitive among universities worldwide (Wæraas & Solbakk, 2009). The deployment of organisational resources for the better performance of end-users and their well-being can be guided by knowing factors influencing university work performance. ICT is increasingly becoming an integral part of institutions of higher education and intends to improve teaching and learning. Nevertheless, for university teachers, students, the rapid iterations and advances of ICT can also cause technostress and make them feel incapable, frustrated, and stressed, thus negatively affecting their work efficiency (Brooks & Califf, 2017; Christian et al., 2020; Li et al., 2020).

Technostress concerning students in different educational institutions is an understudied subject. Individual productivity has been hampered by the proliferation of ICT and ICT-developed platforms at different levels. Each individual has different competency levels of ICT usage, a different mindset, and orientation towards ICT, and different experiences with such platforms but with the combination of these, there is the necessity of a successful implementation of ICT in the current situation (Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Srivastava et al., 2015; Tarafdar et al., 2015).

Individual productivity is affected by different stressors, which are defined as stress creators in different research papers (Chandra et al., 2019; Hwang & Cha, 2018; Marchiori et al., 2019; Ragu-Nathan et al., 2008). The factors that cause technostress can be defined as techno-overload, techno-complexity, techno-uncertainty, techno-invasion, and techno-insecurity. Previous studies have mostly talked about the first three factors in the list, i.e., techno-overload, techno-complexity, and techno-uncertainty (Alam, 2016; Ragu-Nathan et al., 2008) whereas Giorgi et al. (2015) and Tarafdar et al. (2010) have discussed techno-invasion and techno-insecurity.

Tarafdar et al. (2011) portrayed the relationship between technostress creators, technostress inhibitors, and their outcome using factors such as techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno-uncertainty as the components of technostress.

Techno-overload is a scenario where employees are expected to work for longer duration and at a faster speed than before the implementation of ICT due to increased work demand (Tarafdar et al., 2011, 2019). Olaniyi et al. (2014) concludes that techno-overload can result in employees experiencing fatigue and other health problems. Techno-overload contributes to a large number of cumulative trauma disorders that affect the hands, wrists, elbows, arms, shoulders, lower back and cervical spine areas. Studies conclude that techno-overload can cause the emotional exhaustion of the end-user (Christian et al., 2020; Tarafdar et al., 2014, 2015).

Techno-invasions refer to a situation in which organizations expect their employees to be available at any time and every time and be always connected with their work-related affairs (Ragu-Nathan et al., 2008; Tarafdar et al., 2014). Together with techno-addiction, techno-invasion entails that work-related tasks may spill into the worker's private life, endangering their work-life balance (Brivio et al., 2018). The comfort offered by technology also forces workers to conduct work in non-working hours. Therefore, the distinction between work and family becomes blurred, which creates tension between work and family, thus, resulting in a vicious circle. At the same time, people have feelings of being bound to technology; technology disrupts the time and space of workers, making them feel nervous about work. For example, learning new technology or working overtime on weekends can lead to employees' shortage of investment in family time, which causes work-family conflict and results in increased levels of job stress (Brivio et al., 2018; Jena & Mahanti, 2014; Tarafdar et al., 2011, 2014, 2019).

Techno-complexities are described as those moments when an employee feels incapable and low on skills because of the ever-evolving technologies and techniques (Tarafdar et al., 2010, 2014). This situation is created by technological complexities, for instance, the introduction of new software or new platforms. These techno-complexities mean that employees have to constantly reskill and upskill in line with the evolving technologies, which leads to immense pressure to cope with challenges associated with ICT implementation (Brooks & Califf, 2017). Teaching and learning processes with the use of ICT become more complicated than conventional methods in face-to-face classes. Various complicated procedures are present in the integration of ICT in the teaching and learning process. When the end-users fail to understand the critical aspects of ICT in the teaching and learning process, they are more averse to using it. Since the new ICTs are multifaceted and require tremendous effort to understand, in the long run, these kinds of complexity create stress and affect end-user performance (Al-Fudail & Mellar, 2008; Hatlevik & Hatlevik, 2018; Jena, 2015; Li et al., 2020).

Techno-insecurity is described as a situation where employees are always under fear and insecurity of job loss and of being replaced by someone who has a better understanding of technology. Li et al. (2020) explain techno-insecurity in the educational setting. Techno-insecurity is a situation where teachers feel insecure about the presence of ICT because they fear that it could make them redundant. Recent studies conclude that students sometimes take their life because of lack of education due to lack of access to technology (Balachandran et al., 2020; Lathabhavan & Griffiths, 2020; Mamun et al., 2020). Techno-insecurity is motivated by basic things, such as lack of confidence and anxiety in using ICTs in the teaching-learning process, and poor experience in dealing with operational issues related with ICT such as lack of access to ICT facilities and poor connectivity (Shapka & Ferrari, 2003; Vannatta & Fordham, 2004; Wang et al., 2008).

Techno-uncertainty refers to those situations that are not predictable. This unpredictability and continuous change leads to an unstable and unsettled mindset (Ragu-Nathan et al., 2008; Tarafdar et al., 2010, 2015). Technology is changing the dynamics of education, especially the relationship between teachers and students. Many higher educational institutions have already adopted ICT in the teaching-learning process, and there are many others that are in the process of doing so. However, the continuous evolution of technology poses challenges for the educational sector. Some of these challenges include frequent updates and upgrades in ICT, increased cost in operationalizing and maintaining ICTs, and replacing one ICT with another. All these add to techno-uncertainty among teachers and students (Al-Fudail & Mellar, 2008; Burke, 2009; Jena, 2015; Jena & Mahanti, 2014).

End-User Satisfaction

ICT implementation can give rise to several issues, making it challenging to understand and use features. A user always looks for easy to use technology and friendly functional features to access rich content in their desired format (Kanter & Moss, 1985). New technology sometimes creates fear in the mind of employees and limits their capabilities and hinders innovation, experimentation, and risk-taking (Chua et al., 1999; Ragu-Nathan et al., 2008; Tarafdar et al., 2015).

End-user satisfaction refers to the positive response of employees towards the implementation of new software and applications (Domínguez-Escrig et al., 2018; Wixom & Todd, 2005). The use of new technology or software should be effortless (Doll & Torkzadeh, 1988). End-user satisfaction increases if the information provided by the system is accurate, relevant, and timely. This will enable greater comfort with the technology, leading to a stress-free user experience, which in turn leads to an increase in user productivity and innovation (Ragu-Nathan et al., 2008; Tarafdar et al., 2014). There is also improved decision-making by both the employee and the management (DeLone & McLean, 2016; Tarafdar et al., 2011). End-user satisfaction is the degree up to which employees accept new technology in the organisation. Sometimes it is measured quantitatively with the help of output of the technology-enabled work or by improvement in their task efficiency, productivity, and innovation

(Ragu-Nathan et al., 2008; Tarafdar et al., 2014, 2015, 2019). User involvement can be improved by giving proper training on technological changes; in this context, the technostress inhibitors help the users to understand the real benefits of ICT used in the organisation. Also, end-users will be happy to use the ICT in the workplace if the inhibitors are appropriately addressed before the implementation of ICTs (Fuglseth & Sørebø, 2014; Tarafdar et al., 2011).

End-User Performance

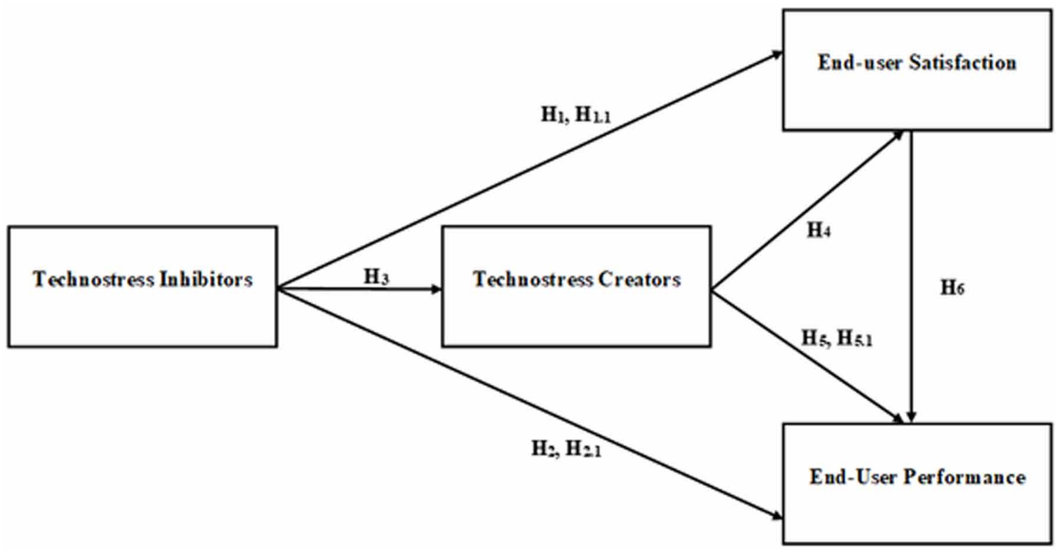
The implementation of ICT in an organisation has changed the nature of work (Saltari et al., 2013). These changes in technology are real-time, complex, incremental, and require the user to use different platforms to capture and process information. The user has to work on the different applications simultaneously, which demands them to be more cautious during the final presentation of the data. ICT users deal with a plethora of information, face constant connectivity issues, and engage in multitasking. Users have to put in continuous efforts to master the frequently changing technology (Ragu-Nathan et al., 2008; Tarafdar et al., 2014, 2015, 2019). Technostress leads to several behavioural issues such as anxiety, panic attacks, procrastination, and insecurity of being replaced by someone who is better at handling technology (Ragu-Nathan et al., 2008; Tarafdar et al., 2014, 2015, 2019; Tu et al., 2005; K. Wang et al., 2005). Studies have verified that the presence of high-level stressors increases the chance of task-specific mistakes and accidents (Kahn & Byosiere, 1992). All these issues affect job satisfaction and the work commitment level of employees. It also creates a negative impact on the creativity and productivity of employees (Tarafdar et al., 2011, 2015).

If organisation inhibitors are worked on effectively and embedded in the system properly, then the impact of technostress creators can be reduced on technology-led innovation and performance. If employees are given training before implementing any new application, their self-belief about technology usage will become positive, and stress creators will have a relatively lower negative impact on performance (Ragu-Nathan et al., 2008; Tarafdar et al., 2010, 2015, 2019). There is a negative relationship between individual job outcomes and technostress. Past research on stress and coping shows that there is an inverted U-shaped relationship between stress and job outcome. The same study conducted in the context of technostress indicates that there is a possibility of an inverted U-shaped relationship between technostress creators and ICT-enabled job outcome (Abualrub & Al-Zaru, 2008; Chandra et al., 2019; Srivastava et al., 2015). Studies show that a moderate level of technostress creators in the organisation leads to higher job outcomes.

Conceptual Model and Hypothesis Development

Many environmental psychology and service marketing studies have used the S-O-R model (Bitner, 1992; Buckley, 1991; Cao & Sun, 2018; Choi & Kandampully, 2019; Luqman et al., 2017; Noble, 1966; Platts, 1972) to explain that the various aspects of the physical evidence act as stimuli (S) which affect the internal states of individuals (O), and which in turn, influence the behavioural responses (R). The model illustrates that an individual's inward states are reinforced by the "Stimuli" found in external aspects. The word "Organism" has been used to refer to the inner states of an individual's perception, emotions, and thought. Previous studies have viewed those constructs to be both positive and negative. Finally, individuals make their final choice and accordingly choose their behavioural "Response." Based on the literature discussions and the S-O-R model, similar theoretical links can be used for the present study. In this study, the technostress inhibitors are considered the stimuli that motivate students to use technology-enabled teaching, and which reduce the behavioural response otherwise called technostress. Finally, reduced technostress positively influences the students' perception and emotions about ICT usage in education, which leads to increased user satisfaction and performance. Moreover, from this model, it can be concluded that technostress creators act as a mediator between technostress inhibitors and students' outcomes in terms of end-user satisfaction and performance. Based on the above discussions and theoretical model, we, therefore, frame the following hypotheses (A conceptual model is shown in Figure 1).

Figure 1. Conceptual Framework



H_1: Technostress inhibitors positively influence students' satisfaction
$H_{1.1}$: Technostress creators mediate the relationship between technostress inhibitors and students' satisfaction
H_2: Technostress inhibitors positively influence students' performance
$H_{2.1}$: Technostress creators mediate the relationship between technostress inhibitors and students' performance
H_3: Technostress inhibitors negatively influence technostress creators
H_4: Technostress creators negatively influence students' satisfaction
H_5: Technostress creators negatively influence students' performance
$H_{5.1}$: Students' satisfaction mediates the relationship between technostress creators and students' performance
H_6: Students' satisfaction positively influences students' performance

METHODS

Sampling

A quantitative methodology was adopted, and an online survey was designed to collect the responses from university/college students from Bangalore, India. The higher education students participating in this study came from four private universities in Bangalore. These universities have implemented a variety of ICT in their classrooms and follow blended learning practices. However, due to the COVID-19 pandemic, as per the UGC directions, these universities adjusted their curricula to fit entirely on online-based teaching. As a result, many higher education students needed to make changes to their learning practice to adapt to ICT-enhanced pedagogy. Data was collected from March 2020 to June 2020. Two hundred and fifteen students pursuing higher education were selected for this study, and the random sampling method was used. Incomplete and invalid samples were removed leaving 206 samples for the study. The data were collected through an online survey. The sample was taken from students from India pursuing higher education and consisted of undergraduate students (10%), and postgraduate students (90%). The ages of respondents ranged from 18 to 29 years, with an average of 22.78 years. Fifty-five percent of the participants were male, and 45% of the samples were female.

Before conducting the survey, the volunteers were provided with a survey form which clarified the aim of the research. They were also assured that the data so collected would remain confidential and anonymous. IBM SPSS 25 and SmartPLS 3 software packages were used to analyse data.

Measures

This research consists of four sections. The first section of the instrument consists of a technostress construct. Technostress creators are used to measure stress experienced by the students when experiencing technology-enabled teaching in higher education. The technostress creator is measured by five subdimensions, namely Techno-overload, Techno-invasion, Techno-complexity, Techno-insecurity, and Techno-uncertainty (Tarafdar et al., 2010). This technostress creator scale consists of 23 items.

The second section includes the items related to technostress inhibitors, adapted from Ragu-Nathan et al. (2008). Technostress Inhibitors were intended to ask respondents' opinions about supportive mechanisms implemented by the institutions of higher education to reduce the negative effects of technostress. These inhibitors were measured by three subdimensions: Literacy facilitation, Technical support provision, and Involvement facilitation, on a scale consisting of 13 items.

The third section of the instrument included items related to end-user satisfaction and performance. The end-user performance construct consisted of 7 items and aimed to measure students' outcomes, quality, and innovation. The end-user satisfaction was intended to measure the students' satisfaction towards the technology-enabled teaching content and the accuracy, ease of use, and timeliness of the information; it consisted of 12 items, adapted from Tarafdar et al. (2010), and initially used by Doll & Torkzadeh (1988). All the items were assessed using a 7-point Likert scale ranging from "1 = extremely strongly disagree" to "7= extremely strongly agree". The individual constructs and related measures are presented in Appendix I. The last section of the instrument included the demographic details of the students, such as age, gender, educational qualification, and type of institution. The validity and reliability of the scales are discussed in the results section.

RESULTS

Measurement Model

The underlying conceptual model was assessed using the Partial Least Squares- Structural Equation Modeling (PLS-SEM) approach using SmartPLS. The reason for using PLS is that it is a flexible modeling approach to SEM with no data distribution assumptions. PLS-SEM is good to use when the sample size is small, the distribution of data is skewed and there is a limited availability of theories to applications (Vinzi et al., 2010; Wong, 2010). Since the sample size was small, and the data was non-normally distributed, SmartPLS 3 software was used to analyse the measurement model and the structural model.

This section explains the validity of the four measurement models and internal consistency reliability. Cronbach's alpha (α) and composite reliability (CR) were the main estimates for measuring internal consistency reliability (Hair et al., 2014). The validity of the measurement models was estimated by checking the convergent and discriminant validity. Convergent validity checks how well the items measure a related construct. In PLS-SEM, Average variance extracted (AVE) and factor loadings of the items (outer loadings) are used to evaluate the convergent validity of the models.

Table 1, 2, 3 and 4 show that the AVE for each construct is above 0.5, which means that more than half of the variances observed in the dimensions are accounted for in the hypothesised constructs and exceed the threshold value of 0.5 or above (Hair et al., 2014), and it reveals the convergent validity (Fornell & Larcker, 1981). Convergent validity is also supported by the composite reliability (CR) of each measure, which is higher than the threshold value of 0.7 or above. Appendix A shows that

Table 1. Technostress Inhibitors Reliability and Validity Measures

Constructs	α	CR	AVE	1	2	3
1. Involvement facilitation	0.853	0.852	0.594	**0.771**		
2. Literacy facilitation	0.875	0.872	0.580	0.584**	**0.762**	
3. Technical support provision	0.845	0.845	0.578	0.750**	0.761**	**0.760**

Note: **p<0.01; Diagonals value the square root of the AVE

Table 2. Technostress Creators Reliability and Validity Measures

Constructs	α	CR	AVE	1	2	3	4	5
1. Techno-complexity	0.827	0.877	0.592	**0.769**				
2. Techno-insecurity	0.835	0.883	0.602	0.452**	**0.776**			
3. Techno-invasion	0.802	0.87	0.626	0.310**	0.352**	**0.791**		
4. Techno-overload	0.857	0.897	0.636	0.336**	0.301**	0.343**	**0.797**	
5. Techno-uncertainty	0.802	0.868	0.623	0.307**	0.214*	0.044	0.271*	**0.789**

Note: **p<0.01; *p<0.05; Diagonals value the square root of the AVE

Table 3. End-user Satisfaction Reliability and Validity Measures

Constructs	α	CR	AVE	1	2	3	4	5
1. Accuracy	0.779	0.780	0.639	**0.799**				
2. Content	0.860	0.859	0.605	0.558**	**0.778**			
3. Ease of use	0.810	0.810	0.681	0.631**	0.494**	**0.825**		
4. Output	0.765	0.765	0.619	0.750**	0.617**	0.623**	**0.787**	
5. Timeliness	0.764	0.768	0.624	0.734**	0.461**	0.744**	0.639**	**0.790**

Note: **p<0.01; Diagonals value the square root of the AVE

Table 4. End-User Performance Reliability and Validity Measures

Constructs	α	CR	AVE	1	2
1. ICT-enabled innovation	0.862	0.862	0.675	**0.821**	
2. ICT-enabled productivity	0.859	0.858	0.603	0.768**	**0.777**

Note: **p<0.01; Diagonals value the square root of the AVE

outer loading of each item is above 0.5 for all research measures and all the items are significant at 1%, and so we retain all the items.

According to Hair et al. (2014), the high-reliability value (CR >0.95) suggests that there are redundant items in the research scale; all our CR values of the constructs are less than 0.95, which shows that there are no redundant items in the research. Cronbach's alpha for all the research constructs is higher than the acceptable threshold of 0.7, which means that there are no reliability issues in this research (Zikmund & Babin, 2010). Discriminant validity checks how well a construct varies from the other constructs in the measurement model, and it is assessed using the Fornell-Larcker criterion

Table 5. Differences between level of technostress based on demographical variables

Technostress Creator	Male (n=113)		Female (n=93)		t value (p value)	UG (n=21)		PG (n=185)		t value (p value)
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
Techno-overload	2.38	0.89	2.23	0.83	1.196 (0.233)	2.57	1.11	2.28	0.83	1.463 (0.145)
Techno-invasion	2.18	0.80	2.19	0.92	-0.056 (0.955)	1.86	0.88	2.22	0.85	-1.862 (0.064)
Techno-complexity	3.06	1.02	2.98	1.00	0.963 (0.565)	3.19	1.18	3.00	0.99	0.798 (0.426)
Techno-insecurity	2.42	0.83	2.35	0.76	0.346 (0.559)	2.31	0.93	2.39	0.78	-0.437 (0.663)
Techno-uncertainty	2.54	0.85	2.68	0.95	-1.100 (0.273)	2.87	0.88	2.58	0.90	1.413 (0.159)

(Fornell & Larcker, 1981). Tables 1, 2, 3 and 4 show that the square root of AVE is higher than inter-construct correlations, which support the discriminant validity of the constructs (Hu & Bentler, 1999) and shows that each construct is unique in this research.

Before testing the hypothesis, the level of technostress was assessed against the demographic variables, such as gender and qualification. An independent sample t-test was used to find the difference in the level of technostress experienced by the students based on their gender and qualification. Table 5 show that male and female students have the same level of technostress. In terms of educational qualification, undergraduate and postgraduate students have the same level of technostress. Among those five technostress components, techno-complexity was the highest, and techno-invasion the lowest, level of technostress experienced by the students.

Structural Modelling and Model Fit Statistics

The path coefficients, T values were obtained by bootstrapping generated by 5000 samples to get a reasonable estimation of standard error. The structural model, along with path coefficients (β), factor loadings, and R square values, are presented in Figure 2. As seen in the figure, all the beta values are significant at the 5% level and above 0.5, showing the significance and relevance of the hypothesis links. Variance inflation factor (VIF) values are used to assess the collinearity issues. Table 6 shows that VIF values are less than 3, which is within the accepted range recommended by Hair et al. (2014) and thus, we can conclude that there are no multicollinearity issues in the research data.

Table 7 shows the model fit statistics summary. The R-square (R^2) is used to measure the proportion of the variance in the dependent variable that is predictable from the independent variable. Hair et al. (2014) suggest a cut-off range for predictive accuracy. An R^2 value between 0.330 to 0.670 means that the predictive accuracy is moderate, and above 0.670 means it is substantial. All three R^2 values range from 0.330 to 0.447, suggesting that they are acceptable; and all the constructs are moderately predicted by the endogenous constructs.

In SmartPLS, the Blindfolding method is used to assess predictive relevance (Q^2). Predictive relevance relates to the "accurate prediction of the data points of indicators in reflective measurement models of endogenous constructs and endogenous single-item constructs". Q^2 values should ideally be greater than zero to have predictive relevance. Hair et al. (2014) recommends a cut-off range for predictive relevance. A Q2 value between 0.25 to 0.35 means that predictive relevance is moderate and a value above 0.35 points to a strong predictive relevance. All three Q^2 values range from 0.219 to 0.244, suggesting that they are acceptable, and the present model has moderate predictive relevance for the endogenous constructs.

Table 6. Collinearity Statistics

Constructs	VIF
Accuracy	1.83
Content	1.37
Ease of use	1.51
ICT-enabled innovation	1.63
ICT-enabled productivity	1.63
Involvement facilitation	1.55
Literacy facilitation	1.63
Output	1.64
Technical support provision	1.90
Techno-complexity	1.43
Techno-insecurity	1.52
Techno-invasion	1.57
Techno-overload	1.48
Techno-uncertainty	1.66
Timeliness	1.66

Note: Accepted cut-off range (VIF < 3)

The overall model fit is assessed using Goodness-of-Fit (GoF). Hair et al. (2014) defines GoF as "how well the specified model reproduces the observed covariance matrix among the indicator items". Tenenhaus et al. (2005) recommends a formula to calculate GoF, which is "the geometric mean of the average communality and average R^2 for an endogenous construct." Wetzels et al. (2009) suggest the cut-off range for accepted GoF ranges As medium between 0.25 to 0.36 is and large for above 0.36. In the present study, the three dependent variables and corresponding GoF values are above 0.36, which testifies to the perfect fit of the model.

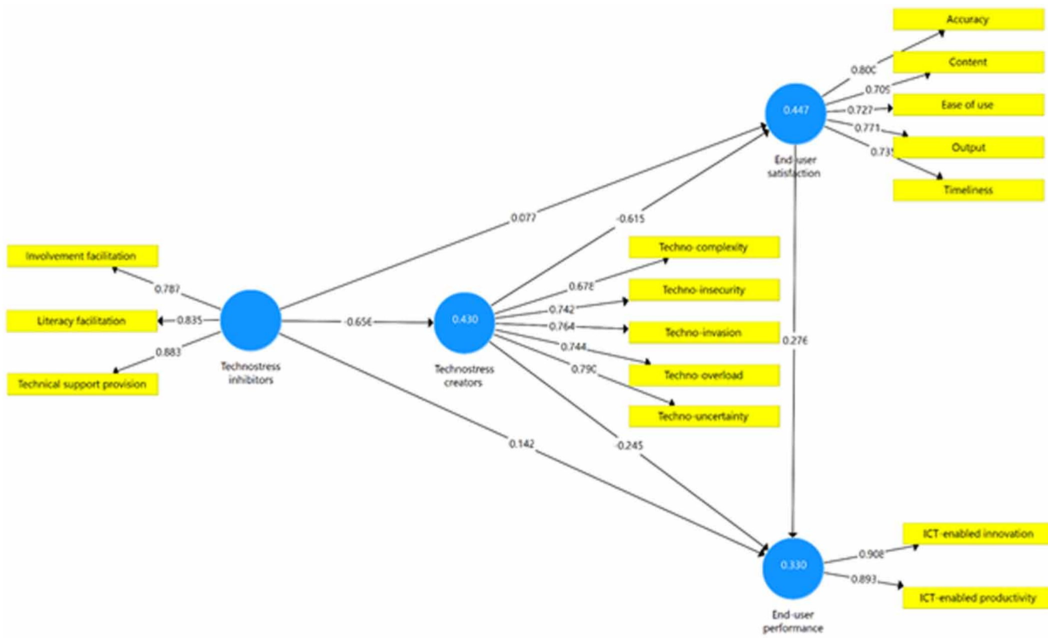
Direct Effect

Table 7 shows the direct path relationships. Technostress inhibitors have a significant direct and negative impact on technostress creators (β=-0.656; t=16.945; p<0.01), thus, H_3 is supported, and technostress inhibitors explain 43% of the variation in the technostress creators. Technostress inhibitors do not have any direct impact on end-user satisfaction (β=0.077; t=1.044; p=0.297) and end-user performance (β=0.142; t=1.655; p=0.098); and thus, H_1 and H_2 are not supported. At the same time, the technostress creators have a direct and negative impact on end-user satisfaction (β=-0.245; t=2.412; p<0.05) and end-user performance (β=-0.615; t=8.92; p<0.01); thus, H_4 and H_5 are supported. The end-user performance is directly, significantly, and positively influenced by the end-user satisfaction (β=0.276; t=2.559; p<0.05), and hence, H_6 is supported.

Indirect Effects

Table 8 shows the indirect path relationships. The technostress inhibitors indirectly affect end-user satisfaction and performance. The end-user is significantly affected by technostress inhibitors via technostress creators. The direct effect between technostress inhibitors and end-user satisfaction is not significant. However, the indirect effect is positive and significant (β=0.404; t=7.205; p<0.01). Hence, the technostress creators act as a full mediator between technostress inhibitors and end-user

Figure 2. Structural Model



satisfaction. Altogether, indirect and direct effects account for 45% of the variation in end-user satisfaction, we can conclude that H1.1 is supported. Technostress inhibitors influence end-user performance via three different indirect relations; 1. Technostress inhibitors → Technostress creators → End-user performance (β=0.161; t=2.345; $p<0.05$); 2. Technostress inhibitors → End-user satisfaction → End-user performance (β=0.021; t=0.917; p=0.359); and 3. Technostress inhibitors → Technostress creators → End-user satisfaction → End-user performance (β=0.112; t=2.244; $p<0.05$). The total indirect effect between technostress inhibitors and end-user performance is significant and direct effect between technostress inhibitors, and not significant for end-user performance. Hence, it can be concluded that technostress creators act as a full mediator between technostress inhibitors and end-user performance, and here, end-user satisfaction does not act as a mediator between technostress inhibitors and end-user satisfaction, thus, H2.1 is supported. Since Technostress inhibitors → End-user satisfaction → End-user performance path is not significant, it implies that technostress creators indirectly influence the end-user performance via end-user satisfaction (β=-0.17; t=2.305; $p<0.05$),

Table 7. Direct Effect and Model Fit statistics

Direct Paths	β	T-value (p-Value)	R^2	Q^2	GoF
End-user satisfaction → End-user performance	0.276	2.559 (0.011*)	0.330	0.244	0.517
Technostress creators → End-user performance	-0.245	2.412 (0.016*)			
Technostress inhibitors → End-user performance	0.142	1.655 (-0.098)			
Technostress inhibitors → Technostress creators	-0.656	16.945 (0.000*)	0.430	0.219	0.484
Technostress creators → End-user satisfaction	-0.615	8.92 (0.000*)	0.447	0.227	0.501
Technostress inhibitors → End-user satisfaction	0.077	1.044 (-0.297)			

Note: **p<0.01; *p<0.05

Table 8. Indirect Effect

Indirect paths	β	T-value (p-Value)
Technostress creators → End-user satisfaction → End-user performance	-0.170	2.305 (0.021*)
Technostress inhibitors→ End-user satisfaction → End-user performance	0.021	0.917 (-0.359)
Technostress inhibitors→ Technostress creators → End-user performance	0.161	2.345 (0.019*)
Technostress inhibitors→ Technostress creators → End-user satisfaction → End-user performance	0.112	2.244 (0.025*)
Technostress inhibitors→ Technostress creators → End-user satisfaction	0.404	7.205 (0.000**)

Note: **p<0.01; *p<0.05

and so $H_{5.1}$ is supported. In this case, both the direct and indirect relationship between technostress creators and end-user performance are significant, and end-user satisfaction acts as a partial mediator between technostress creators and end-user performance. Altogether, indirect and direct effects account for 33% of the variation in the end-user performance.

DISCUSSION AND IMPLICATIONS

This study measures the levels of technostress based on technostress creators and the impact of technostress on students' satisfaction and performance. It also identifies the different support mechanisms (technostress inhibitors) used by the institutions for higher education to reduce the technostress and how it influences students' satisfaction and their performance, which have constituted a less understood view on ICT use in Indian institutions of higher education to date, with students as end-users. Prior studies have acknowledged that technology-enabled teaching has a significant and positive impact on students' performance and satisfaction; however, it is also observed that technology implementation in higher education needs to be done only after getting user acceptance. In many developed countries, such institutes follow blended learning methods by using ICTs along with their traditional teaching methods. Due to the COVID-19 outbreak, they have been forced to use ICT-enabled teaching, which has however failed to receive end-user acceptance (students), thus, directly impacting end-user satisfaction. In this view, findings from previous research have suggested both negative and positive outcomes of technology-enabled teaching.

From this study, it is evident that all three components of technostress inhibitors are significant; however, the technical support provision is the most critical component of technostress inhibitors. The performance of the end-user help desk in terms of accessibility, knowledge, and responsiveness in addressing students' queries related to technology-enabled education helps students to reduce their technostress. When it comes to components of technostress creators, techno-uncertainty and techno-invasion are the most critical components of technostress creators; however, the other three components are also considered as relatively important. Frequent changes and updates in computer software and hardware give techno-uncertainty stress. Since technology-enabled education is new to most students in India, they have to spend more time in mastering the new ICT system, which affects their personal time. Accuracy of the system and output quality are the most crucial components of end-user satisfaction, and innovation related to ICT is an essential component of end-user performance.

The present study conceptualises and empirically validates the relationship between technostress inhibitors, technostress creators, and students' learning outcomes. Findings from our study show that technostress inhibitors do not influence students' satisfaction and performance directly. Technostress creators act as mediators between technostress inhibitors and students' satisfaction and performance; and technostress inhibitors indirectly and positively influence students' satisfaction and performance, in contradiction with Ragu-Nathan et al. (2008). Next, technostress inhibitors negatively impact technostress creators, which directly and negatively affect students' satisfaction and performance. Technostress creators indirectly affect students' performance via their satisfaction. We believe that there are several possibilities for the above results. First, many Indian students are not familiar with technology-enabled teaching, they are used to the traditional teaching-learning process, and so they find it hard to disconnect from traditional methods. Second, students do not have sufficient training or knowledge in using technology-enabled teaching tools, which requires additional time and effort from their side. Third, a significant number of students live in rural parts of India, which does not have sufficient infrastructures to support technology-enabled teaching tools; however, many technology-enabled teaching tools can be accessed through mobile devices. Still, other infrastructure facilities like network speed and hardware devices can be an issue. Since technology-enabled teaching is an entirely new concept, students need to get out of their comfort zones to adopt new teaching and learning methods. These findings are seen to hold true in various industry settings (Ragu-Nathan et al., 2008; Tarafdar et al., 2010, 2011, 2015, 2019).

Theoretical Implications

Our findings make some theoretical contributions, and practical implications. The first contribution is in terms of validating and modelling the mediating role of technostress creators on the relationship between technostress inhibitors and students' outcomes. The components of technostress inhibitors, technostress creators, and students' outcomes are validated as separate measurement models, which can be used as a reliable tool to measure the technostress inhibitors, technostress creators, and students' outcomes. Many studies have attempted to find the link between technostress inhibitors, technostress creators, and employee outcome in terms of employee engagement, commitment, satisfaction, and performance (Fuglseth & Sørebø, 2014; Ragu-Nathan et al., 2008; Tarafdar et al., 2010, 2011, 2015, 2019). However, no academic work has tried to find a similar relationship in student populations, particularly during a worldwide crisis.

As the second contribution, the structural model concludes that students' opinions about the technostress supportive mechanisms negatively stimulate their emotional responses leading to stress, while this technostress negatively predicts student satisfaction and end-user performance. In general, this study supports the S-O-R model, and that it can be used in a technology-enabled educational setting. Thus, this study makes a significant theoretical continuation to work in higher education settings. The structural model holistically presented the problem by explaining its possible antecedents and outcomes, which will give better insight to future researchers who would like to research on technostress in a higher educational setting.

As the third contribution, this study explains the negative impact of technostress inhibitors on technostress creators. Institutions can implement the mitigating strategies explained in this study to reduce stress created by the technology-enabled teaching methods.

Finally, interestingly, our result demonstrates the controversial non-significant direct relationship between technostress inhibitors and students' outcomes, such as end-user satisfaction and performance. Technostress inhibitors are generally viewed as a supportive mechanism used to reduce students' technostress., and students do not perceive them as related to their satisfaction and performance. However, in the organisational setting, these supportive measures help to achieve job-related outcomes, which differ from students' outcomes. Our findings show that, in the higher educational setting, students' performance and satisfaction can be improved by reducing the level of stress created by technology by the effective implementation of supportive measures. Prior studies have not addressed this mediating effect of technostress.

Practical Implications

The current study has a few practical implications. It empirically demonstrates the dimensions of technostress inhibitors, technostress creators, and students' outcomes. When students experience a high level of technostress caused by the implementation of technology-enabled teaching, they may want to distance themselves from technology-enabled teaching tools (Qi, 2019; Wang et al., 2020). Implementing technology-enabled teaching methods immediately without creating the right environment will lead to technostress (Chauvin et al., 2014; Fugate et al., 2011). However, the current pandemic has mandated immediate switching to technology-enabled teaching without the necessary interval to first prepare the ground for its successful acceptance and adoption. This study recommends that higher education institutes and policymakers understand students' desire for a particular level of technology usage in education, before implementing any technology-enabled teaching methods.

Furthermore, this result explains the importance of the IT help desk, ICT literacy, and motivation towards end-user involvement. Institutions of higher education can use the IT helpdesk to seek support for the issues they face while accessing technology-enabled teaching tools. Based on the students' and educators' level of ICT literacy, different levels of training sessions need to be organised with proper feedback mechanisms. Institutions also need to create a culture that motivates educators and students to try new technologies in the educational field. Implementing reward strategies will also encourage effective adoption of technology.

FUTURE SCOPE OF THE STUDY AND CONCLUSION

This study has a few limitations. We recommend using different student outcomes, such as' academic involvement and motivation as factors affecting technology adoption. This study measures end-user performance in terms of students' productivity and ability to innovate, using self-reported online survey data to prove the relationship between technostress inhibitors, technostress creators, and students' outcomes. Data was collected during the COVID-19 outbreak; however, data collected during normal time could add to the results. A comparative study between developed and developing countries will yield better results. This study is based on the S-O-R model; however, future studies need to consider other theoretical models to develop more comprehensive models since the field of ICT is continuously evolving. The impact of students' demographic profiles was not addressed in this study; it is recommended to consider different demographic profiles to assess the level of technostress.

To conclude, technology has revolutionised the way teachers teach students. The current COVID-19 outbreak necessitated educational institutions to use technology-enabled teaching methods to deliver the courses. It is essential to understand the relationship between technostress creators, technostress inhibitors, and students' outcomes. In this study, we show that technostress inhibitors can negatively influence technostress creators and positively indirectly influence students' satisfaction and their performance.

Conflicts of Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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APPENDIX A

Table 9. Factors and statements

Factors	Statements	Outer loading
Technostress inhibitors	**Literacy facilitation (M=2.29; SD=0.88)**	
	Our college encourages knowledge sharing to help deal with new technology	0.660
	Our college emphasizes teamwork in dealing with new technology-related problems	0.676
	Our college provides end-user training before the introduction of new technology	0.790
	Our college fosters a good relationship between IT department and end users	0.824
	Our college provides clear documentation to end users on using new technologies	0.839
	Technical support provision (M=2.47; SD=0.91)	
	Our end-user help desk does a good job of answering questions about technology	0.836
	Our end-user help desk is well staffed by knowledgeable individuals	0.799
	Our end-user help desk is easily accessible	0.699
	Our end-user help desk is responsive to end-user requests	0.698
	Involvement facilitation (M=2.57; SD=0.93)	
	Our end users are encouraged to try out new technologies	0.913
	Our end users are rewarded for using new technologies	0.744
	Our end users are consulted before introduction of new technology	0.767
	Our end users are involved in technology change and/or implementation	0.634
Technostress creators	**Techno-overload (M=2.31; SD=0.87)**	
	I am forced by this technology to work much faster	0.803
	I am forced by this technology to do more work than I can handle	0.754
	I am forced by this technology to work with very tight time schedules	0.733
	I am forced to change my work habits to adapt to new technologies	0.853
	I have a higher workload because of increased technology complexity	0.837
	Techno-invasion (M=2.18; SD=0.85)	
	I spend less time with my family due to this technology	0.734
	I have to be in touch with my work even during my vacation due to this technology	0.876
	I have to sacrifice my vacation and weekend time to keep current on new technologies	0.777
	I feel my personal life is being invaded by this technology	0.771
	Techno-complexity (M=3.02; SD=1.01)	
	I do not know enough about this technology to handle my task satisfactorily	0.850
	I need a long time to understand and use new technologies	0.873
	I do not find enough time to study and upgrade my technology skills	0.678
	I find other students in this college know more about computer technology than I do	0.634
	I often find it too complex for me to understand and use new technologies	0.784
	Techno-insecurity (M=2.39; SD=0.80)	
	I feel a constant threat due to new technologies	0.749
	I have to constantly update my skills to avoid being replaced	0.786
	I am threatened by co-workers with newer technology skills	0.744
	I do not share my knowledge with my co-workers for fear of being replaced	0.835
	I feel there is less sharing of knowledge among co-workers for fearing of being replaced	0.763
	Techno-uncertainty (M=2.61; SD=0.90)	
	There are always new developments in the technologies we use in our college	0.741
	There are constant changes in computer software in our college	0.746
	There are constant changes in computer hardware in our college	0.838
	There are frequent upgrades in computer networks in our college	0.827

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Table 9. Continued

Factors	Statements	Outer loading
End-user satisfaction	**Content (M=2.02; SD=0.73)**	
	The system provides the precise information I need	0.789
	The information content meets with my needs	0.807
	The system provides reports that seem to be just about exactly what I need	0.774
	The system provides me with sufficient information	0.739
	Accuracy (M=2.11; SD=0.68)	
	The system is accurate	0.770
	I am satisfied with the accuracy of the system	0.828
	Output (M=2.23; SD=0.92)	
	I think the output is presented in a useful format	0.799
	The information provided by the system is clear	0.775
	Ease of use (M=2.08; SD=0.67)	
	The system is user friendly	0.822
	The system is easy to use	0.827
	Timeliness (M=2.04; SD=0.63)	
	I get the information I need in time	0.840
	The system provides up-to-date information	0.736
End-user performance	**ICT-enabled productivity (M=1.54; SD=0.73)**	
	This technology helps to improve the quality of my work	0.727
	This technology helps to improve my productivity	0.789
	This technology helps me to accomplish more work than would otherwise be possible	0.755
	This technology helps me to perform my task better	0.832
	ICT-enabled innovation (M=1.86; SD=0.67)	
	This technology helps me to identify innovative ways of doing my task	0.838
	This technology helps me to come up with new ideas relating to my task	0.816
	This technology helps me to try out innovative ideas	0.811

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