Technostress in University Lecturers: An Exploratory Study Using the Job Demands-Resources Theory

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Abstract

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University lecturers are expected to engage with a range of workplace information and computing technologies (ICTs) to fulfil teaching, learning, assessment, administrative and research responsibilities. This cross-sectional, survey-based, study addresses the need highlighted in recent literature for the investigation of the effects of technostress on university lecturers. Technostress arises when the individual finds it challenging to manage workplace ICT-related demands, leading to negative effects for both the individual worker and their employer organisation. Framed within the Job Demands-Resources Theory, the study described here explored ICT-associated technostress as a job demand in higher education workplaces, as experienced by a sample of Irish university lecturers (*N*=77). The relationship between technostress creators and lecturer well-being and work performance was explored. The potential moderating effect of technostress inhibitors in mitigating against these potential negative effects of technostress was also examined.

Quantitative analysis findings suggest that Irish university lecturers experience the following technostress creators: techno-overload, techno-invasion, techno-complexity and techno-insecurity. No significant participant age, gender, or education level-related differences in these scores were identified. Hypothesis testing showed that techno-overload and techno-complexity negatively predict work performance, and positively predict work-related burnout, which was also shown to be positively predicted by techno-invasion. Work-related burnout negatively predicted work performance, but only mediated the relationship between techno-invasion and work performance. Analysis of the mitigating role of technostress inhibitors delivered mixed results, with some findings suggesting that technostress inhibitors potentially magnify, instead of reducing, the negative effects of technostress creators. These quantitative findings were supported by participant narrative contributions about the use of ICTs in higher education workplaces. These narratives supported the discussion of the quantitative analysis results, while also informing recommendations for academic managers regarding organisational measures that can be adopted to identify, and mitigate against, the negative effects of technostress for both university lecturers and their employer universities.

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I commenced this programme of study in October 2020 in a world confined by lockdowns and Covid-19 fears and uncertainties. I dedicate this thesis to those who are bravely navigating the lasting effects of long Covid and other Covid-related challenges, as they too strive to reach their goals in life, and to those for whom the long Covid effects were just too much. RIP my brave Mom. You fought until the end. This one's for you and Dad who looked after you so well.

Declaration

I hereby certify that this material, which I submit for assessment on the programme of study leading to the award of Doctor of Philosophy, is entirely my own work and has not been taken from the work of others, save to the extent that such work has been cited and acknowledged within the text of my work. No part of this work has previously been submitted for any other degree, diploma or other qualification.

The total word count for this thesis is 47,579 words, which includes all figures and tables, but excludes the Title page, Abstract, Contents, List of Figures, List of Tables, Acknowledgements, Declaration, References and Appendices.

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Chapter 1: Introduction and Background

1.1 Overview

Workers may experience the negative effects of technostress in occupational settings when they feel unable to manage the demands arising out of expectations to use workplace information and computing technologies (ICTs) to fulfil work functions. This potentially leads to worker experiences of strain and stress, negatively influencing their well-being (Tarafdar et al., 2007; Berg-Beckhoff et al., 2017; Hwang & Cha, 2018). Research (e.g., McMahon, 2016; Gaebel et al., 2021; Katz & Kedem-Yemini, 2021; Sulaiman et al., 2023) in recent years has shown how university lecturers are expected to engage frequently with a variety of ICTs to fulfil teaching, learning, assessment, administrative and research responsibilities. The exploratory study described here was a quantitative examination of technostress creators and inhibitors, and their association with work-related burnout and work performance, in a sample of university lecturers working in the Republic of Ireland. A cross-sectional, survey-based research design was used to explore these relationships, as framed within the theoretical framework of the Job Demands-Resources Theory of occupational stress and well-being (Demerouti et al., 2001). The discussion of the quantitative data findings was informed by the thematic analysis of participant responses to open-ended statements at the end of the questionnaire.

As a university lecturer myself until December 2022, I experienced working in the Irish higher education context before, during and after the Covid-19 pandemic lock-downs. My training in work and organisational psychology prompted and guided my informal observations of the effects of digitalisation of higher education functions upon both myself and colleagues within my broader work ecosystem. This interest in the university lecturer-ICTs relationship inspired me to further investigate the phenomenon of technostress as experienced by lecturers. My first foray into this topic was in the form of my *ED.S845 Enhancing Higher Education: Policy and Change Processes* module assignment study, titled “Relatedness, competence and academic identity during emergency remote teaching: An interpretative phenomenological analysis”. Although not the core theme of this assignment, participant responses during the interviews undertaken for this previous study suggested that they were experiencing negative effects associated with technology usage expectations of their jobs as Irish university lecturers. These narratives prompted me to further investigate the phenomenon of technostress as experienced by Irish university lecturers, giving rise to this thesis.

The goal of the exploratory research undertaken for this thesis was to promote understanding of academic work environment job characteristics both driving, and potentially mitigating against, technostress and consequences of work-related burnout and work performance, as experienced by lecturers. It is hoped that the findings of this study will contribute towards the conversation in the literature on understanding how job characteristics, particularly those associated with technology usage, may promote or mitigate against work-related stress in universities as occupational settings. The findings of this study may be used to inform understanding of how lecturer-workplace ICT interactions may influence the well-being and work performance of university lecturers, while also providing deeper insights into how lecturers attempt to manage technological demands and resources within their physical and virtual workplace environments. Creating awareness of the influence of workplace technology usage on university lecturers is important, as university management should implement initiatives to improve employee mental health by reducing technostress (Zheng et al., 2022) as part of promoting the engagement, health and well-being of university lecturing staff. Identification and management of technostress in this way would potentially benefit individual lecturers, their employer universities, and students.

1.2 The ROI's changing higher education environment

Higher education in the Republic of Ireland (ROI) previously operated under the auspices of the Irish Department of Education, along with the primary and secondary education sectors. In 2020, the Irish Government acknowledged the significance of the higher education sector by establishing a new Department of

Further and Higher Education, Innovation, Research and Science[1], dedicated solely to post-school study and research, in close alignment with the needs of industry. The Higher Education Authority (HEA) is the designated body with statutory responsibility for governance and regulation in the Irish higher education system[2].

The Irish higher education landscape has traditionally been organised into a binary manner, based on research funding, status and societal esteem. One grouping traditionally comprised seven traditional-type universities. The other grouping comprised 14 Institutes of Technology (IoTs) (Highman, 2020; Houghton, 2020). The Technological Universities Act 2018 paved the way for reforms in both the governance and operation of existing IoTs. This formed the foundation for the establishment of Technological Universities through mergers of existing IoTs in regional clusters, involving most IoTs in the country (HEA, n.d.; Houghton, 2020). Designation of Technological University status was contingent on IoT consortia meeting a range of requirements, including standards of staff qualification, research output quality, and evidence of student engagement in lifelong learning (Highman, 2020). The main strategic aim of these newly-established Technological Universities is to deliver programmes at Levels 6, 7 and 8 (Higher Certificate, Bachelors, and Honours degrees, respectively), as well as industry-focused research (HEA, n.d.). Irish Government strategic objectives aligned with this include initiatives to support the progression of students from the further education and training (FET) sector into higher education. This is being facilitated through consortia agreements under the oversight of the HEA-affiliated National Tertiary Office (NTO)[3], established in 2023. The NTO is dedicated to the creation of a unified third level education system, providing access to both FET and higher education, through a diversity of pathways, with the aim of fostering the development of talent and skills in the ROI (NTO, n.d.). The creation of

[1] https://www.gov.ie/en/organisation/department-of-higher-education-innovation-and-science/
[2] https://hea.ie/
[3] https://nto.hea.ie/about/

Technological Universities therefore represents a new type of higher education institution (HEI) in the Irish university system, challenging the traditional university-IoT binary system (Highman, 2020).

The merger of IoTs into new Technological Universities is associated with a significant period of change for all staff working in these new Technological Universities, with this period of change being years in duration. Amalgamation of IoTs is accompanied by the merging, or replacement of, educational and administrative ICT systems essential to lecturers fulfilling learning, teaching, assessment and administrative functions. For many lecturers, this involves digital upskilling, and the associated adoption of new policies and procedures associated with these new systems, in addition to meeting existing workload responsibilities. These merger-related challenges are taking place against a backdrop of other challenges affecting all HEIs in the Irish higher education landscape. Kinsella (2020) suggests that the Covid-19 crisis "…*exacerbated the considerable pre-existing financial, logistical, and operational pressures confronting universities. These events, in turn, raise questions not alone about the sustainability of their business models but even more fundamentally of their purpose*." (p. 435, 436). Kinsella (2020) further suggests that the convergence of the higher education and technology-based sectors in industry, are prompting universities to be engaged in the "*…generation, transfer and commercialisation of the knowledge economy*." (p. 436). He goes on to surmise that another significant challenge facing the higher education sector is the rapid proliferation of learning technologies in teaching and learning. This has led to a significant dependence within higher education work contexts on Virtual Learning Environments (VLEs) and digital communication platforms, which are both now considered core to third level education delivery and student-staff engagement in a post-Covid-19 world.

This snapshot of the Irish higher education system shows that Irish HEI academic staff are working in times of ongoing uncertainty and change, presenting numerous challenges which is highly influenced by technological dependencies in the ROI university ecosystems.

1.3 Statement of the problem and study rationale

The technological disruption of higher education was already in progress prior to the Covid-19 pandemic (e.g., Jena, 2015; Jensen, 2019) and associated lockdowns increasing reliance on ICT for educational delivery, assessment and administration. The sudden shift to technology-reliant emergency remote teaching due to the Covid-19 pandemic restrictions represented an acceleration of this technological change in higher education that has fuelled an international agenda for the increased future expansion of digitalisation of higher education (Jensen et al., 2022). The reliance on ICT has become an indispensable feature of modern higher education environments (Wang & Zhao, 2023), with Zheng et al. (2022, p. 3) claiming that "*ICT has changed and revolutionized the way learning and teaching is being done now.*" University lecturers are expected to acquire and maintain digital skills, engaging timeously and proficiently with a range of technologies to perform and support their learning, teaching, assessment and administrative functions. They are expected to balance this with multiple teaching, research, administrative and other roles in highly dynamic university work environments, while also meeting high-performance and high-productivity expectations of their employer universities (Amer et al., 2022; Harunavamwe & Ward, 2022; Zheng et al., 2022). This technologically-intensive transformation and disruption of educational service delivery has been recognised in recent literature (e.g., Mushtaque et al., 2021; Aktan & Toraman, 2022; Tlili et al., 2023).

While the emphasis in this thesis is on the negative effects of ICT on university lecturers, it is also acknowledged here that there are also positive effects of work-associated ICTs, as is recognised in the literature (e.g., Tarafdar et al., 2017; Califf et al., 2020; Saidy et al., 2022). Occupational ICTs are often used for utilitarian reasons to meet increased performance and efficiency demands

(Delpechitre et al., 2019; Nastjuk et al., 2023). Positive effects of ICTs in the workplace include enhanced workplace efficiencies, flexibility (Atanasoff & Venable, 2017), accessibility (Ter Hoeven et al., 2016), effectiveness, innovation (Tarafdar et al., 2017), productivity and collaboration between workers (Rasool et al., 2022). While it was once assumed that ICTs would ease employee workload by facilitating increased productivity, it is now recognised that the mandated engagement with ICT to perform core work tasks may instead at times add to the work burden experienced by employees (Yener et al., 2019). This occurs when the workload, unpredictability and interruptions associated with ICT usage becomes stressful (Ter Hoeven et al., 2016), potentially leading to impairment of employee cognitive, psychological and physical health, while also having negative effects on their employer organisations (Atanasoff & Venable, 2017). These negative effects are known as 'technostress', which is defined by Tarafdar et al. (2007) as:

"*… a problem of adaptation that an individual experiences when he or she is unable to cope with, or get used to, ICTs. In the organizational context, technostress is caused by individuals' attempts and struggles to deal with constantly evolving ICTs and the changing physical, social, and cognitive requirements related to their use. Technostress results in a variety of outcomes such as dissatisfaction, fatigue, anxiety, and overwork, leading to a negative effect on individual productivity."* (p. 304)

The negative experiences of technostress that may arise out of technology engagement manifest in the attitude, psychology and behaviours of the individual worker, while also negatively impacting their welfare (Jena, 2015; Tarafdar et al., 2011). The study described in this thesis was undertaken to address a need identified in the literature (e.g., Berg-Beckhoff et al., 2021; Borle et al., 2021) to investigate the effects of technostress within the context of specific occupational domains. This was highlighted by Atanasoff and Venable (2017), who claimed that "…*research is needed to examine technostress differences across industries and identify who is most at risk for any detrimental impacts from technostress and* *how much technostress workers can tolerate before experiencing problems*." (p. 335).

This study specifically addresses a need to investigate the effects of ICT-related stress on university lecturers, which has been highlighted in recent literature (e.g., Boyer-Davis, 2020; Li & Wang, 2021; Amer et al., 2022; Govender & Mpungose, 2022), with Zheng et al. (2022) recommending that future technostress research should investigate the empirical relationships between technostress and employee mental health in university work environments.

Although some of the relationships between the main variables in this study, namely, technostress creators, technostress inhibitors, work-related burnout and work performance, have been identified and explored in the literature on occupational stress, the combination of these constructs as studied here is unique, particularly within the Irish university context.

1.4 Research questions

The research questions presented below arose out of my aim to identify possible ways in which the mandated use of a range of technologies in Irish higher education workplaces – both physical and virtual - is experienced as stressful by university lecturers, as well as the consequences thereof for both lecturers and their employer HEIs, as represented by burnout and work performance measures. The development of the research questions presented here was initially prompted by my own anecdotal observations of academic staff adapting to evolving HEI workplace technologies, with this technological disruption accelerated and intensified by the pivot to emergency remote education associated with Covid-19 lockdowns. However, the formulation of these research questions was primarily driven by participant narratives in the *ED.S845 Enhancing Higher Education: Policy and Change Processes* module study that I undertook during the first stage of this PhD programme.

Even though my *ED.S845* study focused on relatedness, competence and academic identity of lecturing staff during emergency remote teaching (Moore, 2022), it was apparent that participant narratives also emphasised the challenges associated with technological adaptation required for emergency remote teaching. These narratives further acknowledged workplace supports in meeting these challenges as being vital to their ability to fulfil their teaching, learning, assessment and administrative roles and responsibilities. Adaptation challenges, and mitigation measures in the form of HEI supports, were highlighted by participants. These aligned with Tarafdar et al.'s (2007) conceptualisation of technostress creators, and Ragu-Nathan et al.'s (2008) recognition of digital literacy supports as technostress mitigation measures. These included the highlighting of the challenges associated with enforced digital upskilling, while recognising the contributions of both peer-to-peer learning and more formal HEI supports, such as online toolkits, webinars and drop-in clinics in promoting digital literacy of lecturers. Participant narratives in the *ED.S845* study further emphasised the importance of accessibility to, and responsiveness of, HEI supports in acquiring the necessary levels of digital literacy to successfully meet their education and administrative responsibilities in their academic roles. Some participants in this study also bemoaned the lack of time to engage with both formal and informal digital upskilling opportunities, with already-heavy workloads further exacerbated by the mandated use of digital technologies, which in turn, impeded the learning of new and additional educational technologies and associated methodologies due to a lack of time. One participant in this study also expressed the opinion that some of the internet learning resources available for her subject area on publicly-available platforms are superior to what she has the time or skills to produce, fearing that she could be replaced by these freely-available video internet resources. The persistence of some of the online and blended learning practices post-Covid-19 lockdowns has created further technology-related challenges for academic staff, as technological disruption of higher education spaces continues unabated.

Participant narratives in the *ED.S845* study therefore strongly supported the formulation of the technostress creator and inhibitor-related research questions presented here as being relevant to the ongoing adaptation of lecturing staff to the increasingly technological HE landscape. These questions framed and guided all research stages and conclusions associated with this study. The research questions are summarised here:

Research Question 1:	What are the predominant technostress creators experienced by a sample of Irish university lecturers?
Research Question 2:	Are there differences in the levels of technostress of a sample of Irish university lecturers, as defined by demographic variables of age, gender and level of education?
Research Question 3:	Do relationships exist between measures of technostress creators, work-related burnout and work performance of Irish university lecturers?
Research Question 4:	Do technostress inhibitors have a role to play in the relationships mentioned in *Research Question 3*?
Research Question 5:	Is the Job Demands-Resources model adequate for describing the relationships between the variables named in *Research Questions 3 and 4*?

1.5 Thesis structure

The hypothetico-deductive approach as adapted from Gray (2021) was adopted here, as demonstrated using the stages shown in *Figure 1.1*. The thesis chapters outlined below align with these stages.

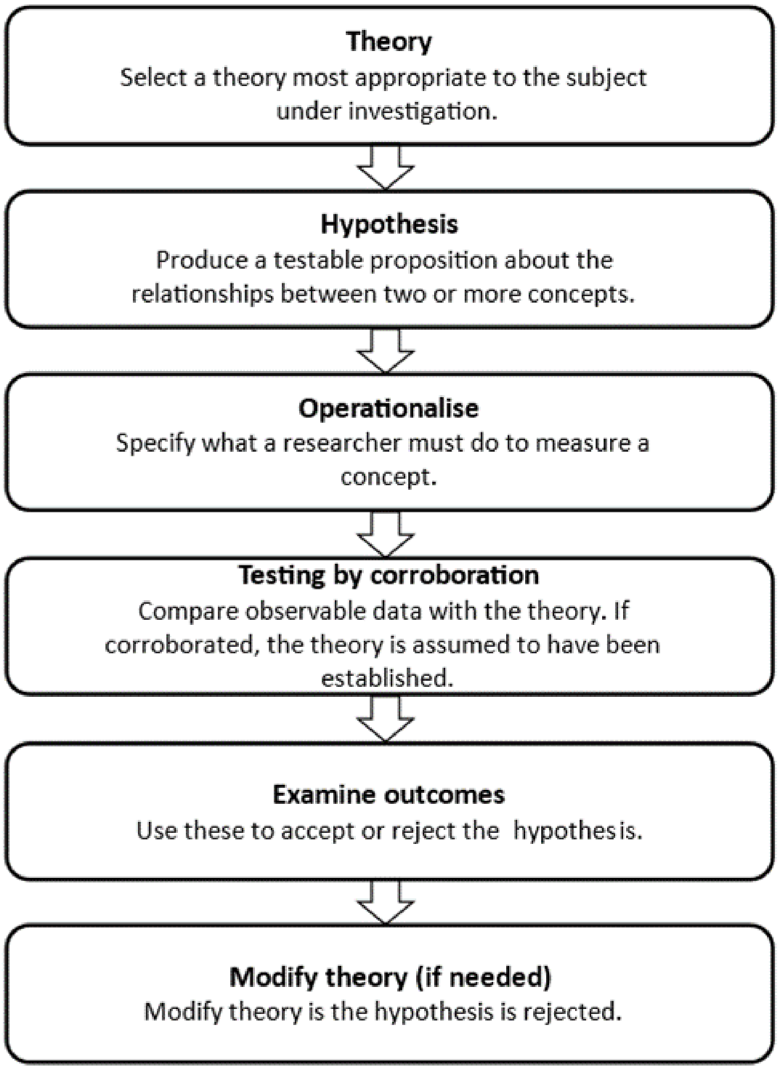

Figure 1.1 Hypothetico-deductive method

There are six chapters in this thesis. This first introductory chapter (Chapter 1) gives an overview of the study, statement of the problem and rationale for the study, and presents the research questions.

Chapter 2 commences with an outline of the literature search strategy adopted to inform the literature review and development of the research hypotheses. The Job Demands-Resources model as an occupational stress model providing the theoretical framework for this study is explained, both in general terms, and with reference to its application in higher education work contexts. An overview is then given of technostress, followed by the exploration of its potential role in generating occupational stress in higher education settings. Hypothesis development first explores the differential levels of technostress creators when compared to one another and an overall technostress creator measure. This is followed by an exploration of whether participant demographic factors (age, gender, level of education) influences the level of technostress creators experienced. The potential for a negative predictive relationship between technostress creators and work performance is then explored, as is the potential positive predictive relationship between technostress creators and work-related burnout. The relationship between work-related burnout and work performance is then examined, before the role of work-related burnout as a potential mediator in the technostress creator-work performance relationship is then considered. The potential role of technostress inhibitors as moderators in the technostress creator-work performance and technostress creator-work-related burnout pathways is then described. A moderated mediation model, incorporating all the afore-mentioned relationships, is then proposed.

Chapter 3 provides a description of the research philosophy adopted for this study, followed by a summary of ethical considerations. Participant sampling is then described, followed by a description of the questionnaire (Appendix) used for data gathering. The quantitative data analysis strategy is then explained. This is followed by a brief overview of how participant responses to the open-ended statements at the end of the questionnaire were thematically analysed.

Chapter 4 presents the findings of both the quantitative data analysis and thematic analysis of the questionnaire responses.

Chapter 5 as the discussion chapter describes the key findings of the quantitative analyses, informed by thematic data generated from participant responses to the open-ended statements at the end of the questionnaire, as well as extant literature. The practical implications of the findings are then described, including a list of recommendations that could be used by university managers in attempting to mitigate against technostress experienced by university lecturers. Limitations of the study and how these may be addressed in future research complete the discussion.

Chapter 6 as the concluding chapter, summarises the final conclusions of this study, with reference to the need for consideration of technostress and its impact on university lecturers in Irish HEIs.

Chapter 2: Theoretical Framework and Hypothesis Development

2.1 Introduction

This section commences with an overview of the search strategy used to inform the narrative literature review (e.g., Borle et al., 2021) supporting the theoretical framework and hypothesis development. This is followed by a description of the Job Demands-Resources model used to frame the exploration of the relationships between technostress creators, technostress inhibitors, work-related burnout and work performance in higher education work contexts, as experienced by university lecturers. The conceptual framework for the study is then presented, followed by a description of the literature review and hypothesis development. This chapter concludes with a summary of the hypothesis statements.

2.2 Literature search strategy

The review of the literature informing the development of the hypotheses for this study was undertaken in accordance with Frey's (2018) criteria for a literature review's appropriateness for the purpose for which it is intended. This includes:

(1) It must be comprehensive enough to include the main sources relevant to the topic.

(2) It must be relevant, excluding sources with little direct bearing on the topic.

(3) It must represent contemporary research or thinking in the area of investigation.

(4) It must be unbiased, refraining from advancing one viewpoint, while excluding others.

Electronic databases (ERIC, PsychInfo, Scopus, PubMed) were searched in the period from May 2022 to May 2023. Search terms used were "job demands-resources theory", "job demands-resources model", "technostress", "technostress creators", "technostress inhibitors", "burnout", "productivity", "innovation", "work performance", "university", "higher education", "lecturer", "academic", "faculty" using Boolean terms. Only the term "technostress" was searched to represent the stress arising out of negative employee-technology interactions, as it is a well-defined term that has been used in a wide range of publications. Although these interactions have been described in some of the literature using other terms such as "technophobia", "cyberphobia", "computerphobia", "computer anxiety", "computer stress", "negative computer attitudes" (Wang et al., 2008) and "digital stress" (La Torre et al., 2019), there is no widely-used definition of these. Exploration of these employee-technology interactions in this thesis with reference to technostress creators (Tarafdar et al., 2007) and technostress inhibitors (Ragu-Nathan et al., 2008) allows for the consideration of a range of possible technostress predictors and mitigants with reference to published and established technostress definitions. Supplemental searches were also carried out to identify further literature relevant to the topic of this study. The literature presented here draws on studies of technology-associated stress in higher education environments, as experienced by staff and students, as well as teacher experiences of technostress in secondary settings and technostress experiences of employees in a variety of other occupational settings.

2.3 Job Demands-Resources Model

This section provides an overview of the Job Demands-Resources model of occupational stress and well-being, followed by a discussion of its potential use in exploring the technology-related job demands and resources as experienced by university lecturers within higher education environments.

This Job Demands-Resources model, proposed by Demerouti et al. (2001) and further developed by Bakker and Demerouti (2007), is widely recognised as one of the main occupational stress and well-being models. According to Bakker et al. (2023, p.32), this model provides for a "…*comprehensive understanding of employee well-being and performance*…". It has proven validity across multiple occupational sectors (e.g., Delpechitre et al., 2019; Lesener et al., 2019; Mazzetti et al., 2021; Taser et al., 2022). Rattrie and Kittler's (2014)'s systematic review also evidenced convincing support for the Job Demands-Resources model in different national contexts, further lending credibility to the use of this model as a valuable tool for exploring the relationships between job characteristics and employee well-being, as defined by burnout and work engagement.

The original conceptualisation of the Job Demands-Resources model suggests two main categories of job characteristics: job demands and job resources. Job demands are occupational stressors that are physical, social, or organisational job-related characteristics requiring sustained physical or mental effort by the employee, which may be perceived by the individual worker as threats in the workplace[4]. Such job demands are often associated with employer expectations of sustained work-related effort to manage heavy workloads and work-related demands. The perception of these demands as threats may result in negative physiological and psychological consequences for the worker. The adoption of compensatory strategies in an attempt to manage these negative consequences may over time lead to the depletion of the individual's energy resources, ultimately resulting in a state of exhaustion. These negative effects are known as the burnout (health impairment) pathway in the Job Demands-Resources model (Demerouti et al., 2001; Bakker et al., 2010; Bakker et al., 2023). Job demands may therefore reduce the individual worker's coping ability, leading to further withdrawal behaviour, and ultimately, disengagement from work, which would have negative consequences for their employer organisation (Demerouti et al., 2001).

Job resources refer to the physical, psychological, social, and organisational job characteristics that stimulate growth, learning and development in support of the

[4] "Workplace" is used throughout this thesis to refer to both physical and virtual workspaces.

achievement of work goals. Examples of organisational job resources are physical aspects of the work environment, job control, participation in decision-making, task variety, collegial and peer support. As these job resources are likely to lead to positive outcomes for the individual employee and employer organisation, it is known as the engagement (health promotion) pathway (Demerouti et al., 2001; Bakker et al., 2010; Ingusci et al., 2021). Job resources may also interact with job demands to regulate the potentially negative individual and organisational impacts of these demands and the associated adverse physiological and psychological costs to the individual. This is known as the "buffer hypothesis" whereby job resources can weaken or buffer job demands' unfavourable impacts on health, well-being and performance (e.g., Bakker et al., 2005). This is contingent on a sufficient type and level of job resources. Whether these individual employee and organisational outcomes are negative (unfavourable) or positive (favourable) depends on the relationships between the job demands and job resources within the work environment (Demerouti et al., 2001; Bakker & Demerouti, 2007). The achievement of work goals is hampered when a deficiency of resources in the work environment leads to a situation where individual workers cannot cope with the negative influences of that environment (Demerouti et al., 2001). This suggests that an insufficiency of job resources may promote the health impairment pathway of the Job Demands-Resources model (Schaufeli & Bakker, 2004; Alarcon, 2011).

The Job Demands-Resources model was selected to frame this study in preference to alternative occupational stress models and theories, briefly described here. The Person-Environment Fit Theory emphasises the social construction and optimisation of the alignment of the person with their job characteristics and work environment, without making a clear distinction between job characteristics as demands or resources (Wang & Tan, 2020; Jaiswal et al. 2022). This person-job fit also underpins Job Crafting Theory, which emphasises how the adoption of proactive behaviours by a worker can result in a reduction of demanding job characteristics, while fostering perceived resources in the workplace to increase alignment of job characteristics with individual abilities and needs (Ingusci et al., 2021). The Job Characteristics Model also emphasises the person's response to their work environment, as a function of individual characteristics and job characteristics, emphasising the former (Thomas et al., 2004). Mitigation of the negative effects of work environments on the individual employee at a personal level are central to the Transactional Model of Stress and Coping (Pflügner et al., 2021). Similarly, the Job Demand-Control-Support Model posits that social supports and job control in the workplace buffer against the negative effects of employee strain (Dawson et al., 2016). Employee-work environment interactions are also central to the Sociotechnical Theory. This theory emphasises the need for optimal balance between personal skills, attitudes and values, and the technical and task-related aspects of their work environment, in driving employee engagement (Tarafdar et al., 2007; Picazo Rodrıguez, et al., 2023). While the alternative theories and models mentioned here have been applied in occupational stress research, none of these are as widely accepted, validated and published in the literature as the Job Demands-Resources model.

The systems-based approach of the Job Demands-Resource model provides a more holistic consideration of individual and workplace characteristics than these alternative models. Furthermore, it facilitates a greater scope for the manipulation of job demands and resources, as well as consideration of personal employee characteristics. This allows for the flexible positioning of workplace ICTs as job resources or workplace demands, while assessing the possible personal and organisational outcomes of worker-ICT engagement along health promotion and/or impairment pathways. This flexibility of the Job Demands-Resources Model further allows for the monitoring of workplace technostress mitigation measures and their impacts on both the individual employee and associated organisational outcomes.

The Job Demands-Resources model therefore provides a flexible and adaptable framework within which potentially threatening occupational environment characteristics, occurring at both the individual worker or organisational level, can be evaluated, with consideration of the well-being outcomes for the individual and consequences for the employer organisation (Demerouti et al., 2001; Bakker et al., 2010; Bakker et al., 2023). This model can be used to explore individual-level and organisation-level factors to explain the workplace factors promoting, or mitigating against, worker well-being in response to work-related ICTs. This model frames the hypotheses in this study, positioning workplace ICT as an occupational stressor. Most modern workplaces, such as HEIs, mandate that workers engage with workplace technologies to fulfil their work functions and responsibilities. This leads to workplace stress when expectations surrounding the use of these technologies, and the supports given to staff in managing the demands of these technologies, exceeds the ability of the individual worker to cope with the work-associated demands placed on them due to these technologies (Wang et al., 2008; Tarafdar et al., 2011). The next section specifically considers the potential use of the Job Demands-Resources model to explore the job demands and resources of higher education work contexts.

The Job Demands-Resources Model and higher education work environments

The Job Demands-Resources model was deemed suitable for this study due to the flexibility of this framework in examining both job demands and job resources, as well as their interactions, in the prediction of personal and organisational outcomes (Demerouti et al., 2001; Bakker et al., 2010; Bakker et al., 2023). Furthermore, this model was deemed suitable for the study described here, as it has been used in previous studies (e.g. Boyd et al., 2011; Barkhuizen et al., 2014; Mudrak et al., 2018; Cao et al; 2020; Dixit & Upadhyay, 2021; Garraio et al., 2022; Harunavamwe & Ward, 2022; Huang & Wang, 2022; Naidoo-Chetty et al., 2022) of the occupational well-being of higher education academic staff. As the context for this study is the Irish higher education environment, it is also relevant to note that Russell et al.'s (2018) government-commissioned report on *Job Stress and Working Conditions: Ireland in Comparative Perspective* also advocates for the use of the Job Demands-Resources framework to investigate occupational stress. The use of such a well-being framework for the exploration of job demands and job resources in Irish academic environments is further supported by Shankar et al.'s (2021) conclusion that "*The ongoing organisational reform of Irish higher education around market principles has failed to account for staff welfare, health and wellbeing; the global health crisis has brought these trends into even more stark relief."* (p. 174).

The study described here applies the Job Demands-Resources model to an investigation of technostress as a job demand and antecedent of work-related burnout and reduced work performance, while also investigating the potential of technostress inhibitors, as job resources, to mitigate against these negative effects as experienced by university lecturers in technology-reliant higher education workplaces. Even though the study described here did not explicitly aim to explore the experiences of Irish university lecturers post-Covid-19-lockdowns, the experiences of most lecturers of accelerated and enhanced technology engagement associated with the lockdowns and forced emergency remote working practices, are likely to influence questionnaire responses selected. It is therefore relevant to note that the literature (e.g., Mushtaque et al., 2021; Demerouti & Bakker, 2022; Garraio et al., 2022; Harunavamwe & Ward, 2022; Karatuna et al., 2022) also supports the use of the Job Demands-Resources model in investigating the influence of Covid-19 on personal and organisational outcomes.

The literature therefore provides evidence in support of the application of the Job Demands-Resources model in the study described in this thesis, in exploring the relationships between technology stressors and inhibitors and the Irish university lecturer well-being and work performance. Hypothesis development and the associated conceptual framework for this study is described next.

2.4 Conceptual framework

The conceptual framework for this study is summarised in *Figure 2.1.* This aligns with Bakker et al.'s (2014) conceptualisation of the relationship between job demands and job performance through exhaustion (a component of burnout). This positioning of technostress creators as job demands along the burnout (health impairment) pathway, resulting in both work-related burnout and reduced work performance of the employee concurs with the approach adopted by Yener et al. (2021) and Philip and Kosmidou (2022) in their studies of the effects of technostress in the workplace.

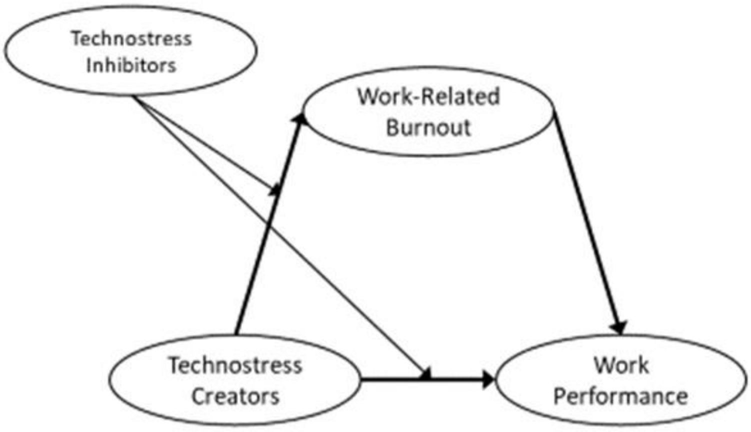

Figure 2.1 Conceptual framework

Figure 2.1 positions technostress creators as predictors of both work performance and work-related burnout in Irish university settings. Work-related burnout is also positioned as a predictor of work performance. Technostress inhibitors are positioned as moderators of the technostress creator-work-related burnout and technostress creator-work performance relationships. This positions the interactive effects of technostress creators and technostress inhibitors as predictors of both work performance and work-related burnout. These relationships are explored through a series of hypotheses in the next section. Hypothesis development is drawn from technostress literature, predominantly aligned to disciplines of education, psychology, business and human resources. The predictor (X), outcome (Y), mediator (M) and moderator (W) variables associated with each of these hypotheses is clearly identified.

2.5 Literature review and hypothesis development

The main aims of this study were to explore the technostress creators experienced by Irish university lecturing staff, while also probing the consequences of such with reference to work-related burnout and work performance. The potential for technostress inhibitors to mitigate against these negative effects is also examined. This section commences with an explanation of the concept of technostress and its association with occupational stress. Hypothesis development is then described, supported by the technostress literature and other relevant publications to explore the relationships between study variables.

2.5.1 Technostress as an occupational stressor

Stress is the psychological, behavioural or physical manifestation experienced by individuals in response to situations that are perceived to be demanding or threatening. These circumstances may be physical, emotional, social, economic or occupational, (Nairne & McBride, 2022) perceived by the individual as being excessive relative to their personal capabilities and external resources available to meet these demands. The stress arising from this imbalance is potentially further exacerbated when accompanied by the anticipation of negative consequences arising out of a failure to meet these demands (Tarafdar et al., 2007).

The pervasiveness of ICTs, wireless and mobile computing, as a job characteristic of modern-day occupational settings means that many workers are connected to their jobs almost anywhere, and at any time. Workers are required to maintain ongoing technical competence, while adapting to changing technologies, and meeting organisational expectations of higher levels of work productivity (Wang et al., 2008; Ayyagari et al., 2011). In using work-related ICT, they also potentially have to cope with, and seek resolution to, system problems and errors, steep technology-related learning curves, and higher technology-use related workloads (Tarafdar et al., 2010). According to Ayyagari et al. (2011), ICT-related stress is distinct from general work stress, while also adding to overall work stress even when job demands, demographics and other job variables are controlled.

The study described in this thesis positions workplace ICTs as workplace stressors, known as technostress creators (Tarafdar et al., 2007; Tarafdar et al., 2011). The term "technostress" was first proposed by Brod (1984), to refer to the stress associated with the use of ICT, and its impact on the user's physical and psychological well-being. He proposed this as a 'disease of adaptation', caused by an inability to cope with workplace technological demands. Workers may experience a stress response arising from expectations that they meet the challenges associated with constantly-evolving ICTs, and associated changes in the physical, social and cognitive requirements associated with their use (Tarafdar et al., 2007). Difficulties in adapting to, managing or enduring such occupational ICT-associated demands is likely to lead to workers experiencing psychological, emotional and physical strain or tension (Berg-Beckhoff et al.,2017; Hwang & Cha, 2018). That engagement with ICTs is often a mandated work requirement may further enhance the level of ICT-related stress experienced by workers (Tarafdar et al., 2007). Technostress experiences occur daily at work, as well as in times of crisis for employees (Ioannou et al., 2022).

The negative consequences of technostress should be considered at the levels of both the individual worker, and their employer organisation (Tarafdar et al., 2007). Individual-level experiences of work-related technostress may lead to the experience of physical symptoms of technostress, including increased heart rate, muscle tension, pain, insomnia, headaches and sweating. Psychological technostress-related symptoms may manifest in both behavioural and cognitive ways. This includes anxiety, fear, fatigue, depression, irritability, negative self-evaluation, behavioural changes, reduced sexual desire and generalised apathy (Tarafdar et al., 2007; Jena, 2015; Tarafdar et al., 2015; Govender & Mpungose, 2022). This evidences how technostress may negatively impact an individual worker's overall quality of life (Nimrod, 2018). Negative organisational-level outcomes of technostress experienced by workers includes reduced job satisfaction (Tarafdar et al., 2007; Ragu-Nathan et al., 2008; Jena, 2015; Suh & Lee, 2017); reduced work productivity and work performance (Tarafdar et al., 2007; Ragu-Nathan et al., 2008); reduced organisational commitment (Ragu-Nathan et al., 2008; Tarafdar et al., 2010; Hwang & Cha, 2018). Turnover intention and organisational commitment are also negatively affected (Ayyagari et al., 2011). It can also lead to dissatisfaction with work-related ICT systems and applications, leading to reduced success in worker adoption of new workplace technologies (Tarafdar et al., 2010).

Atanasoff and Venable (2017, p. 326) recommended that research is needed to "…*examine the effects of technostress across different industries, to identify workers at greatest risk of adverse effects."* Technostress specific to higher education work contexts is discussed next.

Technostress in higher education settings

ICTs were already revolutionising learning and teaching in higher education prior to the rapid pivot to technology-reliant emergency remote teaching associated with the Covid-19 pandemic restrictions (Jena, 2015). The accelerated pace of technological change in higher education arising out of this sudden shift to emergency remote teaching, learning, assessment and administration of all higher education functions due to Covid-19 lockdowns has resulted in ongoing change and further embedding of these practices and processes. The educational environment has undergone a technology-intensive transformation in educational service delivery (Aktan & Toraman, 2022).

The use of digital technologies for learning, teaching and assessment purposes remains pervasive in contemporary higher education environments. Benefits of ICT use in higher education include promoting learner access to quality educational resources, and provision of learners with convenience and personalised learning experiences (Li & Wang, 2021). While some academics are comfortable with increased levels of technology use, others may not be as amenable to technological change, finding it difficult to adapt (Jena, 2015) to the technological landscape characteristic of modern higher education work environments. Increasing expectations associated with the use of ICT for teaching, learning, assessment and administrative activities may lead to university lecturers experiencing work overload, changed work patterns and role ambiguities (Li & Wang, 2021; Saleem et al., 2021). Other digital transformation-associated challenges facing university lecturers include the requirement to balance multiple teaching, research, administration, and other roles in a dynamic work environment, while also meeting these high-performance expectations of their employer universities (Amer et al., 2022; Harunavamwe & Ward, 2022) to meet increased performance and productivity demands (Saleem et al., 2021; Zheng et al., 2022). University lecturing staff are also expected to adopt a range of new pedagogical practices, such as game-based learning, mobile learning, flipped classroom (Li & Wang, 2021), blended learning (e.g., Boelens et al., 2018) and Hyflex (e.g., Thomson et al., 2022) and other approaches. While many academic staff are comfortable with increased technology use to fulfil academic responsibilities, others might not be as comfortable with academic workplaces that are increasingly defined by digital technologies. Those academic staff who lack the necessary technological skills, or find it hard to adapt to technological change, will most likely manifest technostress, leading to reduced work performance, commitment and motivation (Jena, 2015).

To meet the technological demands described above, university lecturers have to be skilful in using a range of hardware and software applications, while also ensuring that this knowledge and proficiency in using educational and learning administrative technologies is maintained. This applies to both technology-enabled face-to-face (onsite) teaching and assessment, as well as online learning spaces (Aktan & Toramen, 2022). Modern-day university lecturers are therefore expected to be adept at using learning management systems (e.g., Sulaiman et al., 2023), virtual learning environments (e.g., McMahon, 2016), video communication and online collaboration technologies (e.g., Katz & Kedem-

Yemini, 2021), social media sites (e.g., Rowell, 2019) and others, such as timetabling and programme information systems, while also adapting to the use of hardware such as laptops, tablets and mobile phones (Govender & Mpungose, 2022). Online education environments have been recognised as being particularly reliant on the excessive use of new technologies and work activities, with their use often extending into the personal time of the lecturer (Harunavamwe & Ward, 2022). This may result in academic staff experiencing psychological strain, and the depletion of mental resources, leading to work-related burnout (Amer et al., 2022).

2.5.2 Technostress creators

The multi-dimensionality of technostress is reflected in Tarafdar et al.'s (2007) conceptualisation of "technostress creators" as factors that cause technostress (Tarafdar et al., 2015; Wang & Zhao, 2023). Tarafdar et al. (2007) proposed five main creators of technostress: techno-overload; techno-invasion; techno-complexity; techno-insecurity and techno-uncertainty. According to Rohwer et al. (2022)'s systematic literature review findings, this classification of technostress creators has been the most widely adopted in the literature. The literature presents both general occupational applications of this technostress classification system (e.g., Hwang & Cha, 2018; Molino et al., 2020; Ingusci et al., 2021; Pffafinger et al., 2022), as well as studies in the higher education domain (e.g. Jena, 2015; Boyer-Davis et al., 2020; Upadhyaya & Vrinda, 2021).

Each of these five technostress components has the potential to increase strain-related ICT outcomes for workers (Fugelseth & Sørebrø, 2014). These creators may be considered individually, or collectively, as organisational factors in determining the levels of technostress experienced by the individual worker, potentially fostering the development of negative individual and/or organisational outcomes (Rohwer et al., 2022; Vergine et al., 2022). The five technostress creators are now explored here individually, with data analyses including measures of technostress at an individual question item level, average technostress creator level for each of these five technostress creators, and for the overall Technostress Creator Scale. Techno-overload, techno-invasion and techno-complexity are the most widely studied technostress creators (Rohwer et al., 2022).

Techno-overload

The many ICTs that modern-day workers have to use, including mobile computing, collaborative applications, desk top notifications and emails, demand that the worker attempts to cognitively process information streams delivered to them simultaneously. The worker is likely to feel inundated with information, as it demands increased cognitive processing requirements and a faster pace of work to be able to respond to this information within expected timeframes. The prioritisation of relevant and useful information in this communication and notification deluge also becomes challenging, potentially leading to compromise of the worker's efficient cognitive processing. Having to then work through less relevant information, while trying to identify and prioritise relevant information, reduces the amount of time that a worker is available to spend on more relevant and priority tasks (Tarafdar et al., 2007; Tarafdar et al., 2011). This may lead to a feeling of overload due to technology-facilitated communications, which is further compounded by ICT-facilitated frequent interruptions and employer expectations of multi-tasking (Dragano & Lunau, 2020). This often demands a faster pace of work for longer durations of work (Tarafdar et al., 2007). Workers therefore become trapped in almost habitual multitasking, leaving them little time to spend on longer tasks requiring sustained and creative thinking, leading to reduced employee productivity (Tarafdar et al., 2011).

Techno-invasion

Closely aligned to techno-overload, techno-invasion is related to the "always-on" demands of digital technologies, whereby a worker is expected to always be connected to, and contactable by, their employer, reachable anywhere, at any time. This might result in workers feeling that they have reduced control of their work time, with an associated sense of having their personal, non-work, space invaded. This ultimately leads to work-life conflict challenges and a loss of work productivity. Technology-facilitated invasion of a worker's non-work time may also lead to a sense of privacy deprivation when workers feel that they are expected to respond to work-related communications in real-time, even when taking place outside of normal agreed working hours. This may lead to the worker feeling unsettled if not engaging with this expectation of out-of-hours work communication (Tarafdar et al., 2007; Tarafdar et al., 2010).

Techno-complexity

Workers may be intimidated by the complexity of an array of applications, functions and technical jargon. This increasing complexity of ever-changing ICTs may lead to a feeling of overwhelm and a perceived inability to cope. The worker needs to invest time and effort to learn and understand new digital technologies, while also regularly updating their technical knowledge and capabilities. ICT users may be unwilling or unable to maintain the frequent skill development needed to keep pace of constantly-evolving work-related ICT changes, thereby hindering them from being innovative at work, while also adding to their perception of work overload due to technologies. Furthermore, where an employee experiences ICT as too complex, they may require support in trouble-shooting some of the difficulties experienced when adapting to new ICTs. Technical assistance may also be required to resolve these issues. This may lead to delays in achieving ICT-facilitated tasks. These factors related to techno-complexity are likely to lead to increased work errors, reduced time efficiency and reduced work productivity (Tarafdar et al., 2007; Tarafdar et al., 2010).

Techno-insecurity

Techno-insecurity describes the fear of being replaced by others with more up-to-date and in-demand digital skills, or being replaced by the technologies themselves, leading to job losses (Tarafdar et al., 2007) or degradation of work status (Dragano & Lunau, 2020).

Techno-uncertainty

Techno-uncertainty arises when a worker feels unsettled due to the ongoing evolution of workplace hardware and software upgrades (Tarafdar et al., 2007), demanding constant adaptability to change (Dragano & Lunau, 2020). Techno-uncertainty also arises when the change is so frequent and extensive that employees do not have a chance to develop experience in using a particular application or system, with their knowledge rapidly becoming obsolete, resulting in feelings of stress and anxiety (Tarafdar et al., 2010).

When considered within the context of the Job Demands-Resources model, Ragu-Nathan et al. (2008) positions these technostress creators as ICT-related job demands. Pfaffinger et al. (2022) concur with this, proposing that technostress creators are considered stressors according to traditional occupational stress models, such as the Job Demands-Resources model. They concluded that technostress creators are job demands that require effort, or lead to reduced perception of employee control over their work environment, leading to feelings of stress and strain, negatively affecting worker well-being.

The development of the hypotheses for this study is described in the remainder of this chapter. All hypotheses described here were tested with reference to the responses of the Irish university lecturers who participated in this study. *Hypotheses 1* to *3* investigate the relationship between technostress creators and the demographic variables of age, gender and level of education. *Hypotheses 4* and *5* explore the relationship between technostress creators and work performance, and work-related burnout, respectively. The relationship between work-related burnout and work performance is examined in *Hypothesis 6*, while the mediation effect of work-related burnout in the technostress creator-work performance relationship is captured by *Hypothesis 7*. *Hypotheses 8* and *9* examine the moderating effect of technostress inhibitors on the technostress creator-work performance and technostress creator-work-related burnout pathways respectively. The models as explored in *Hypotheses 4* to *9* are combined into a single moderated mediation model for *Hypothesis 10*.

2.5.3 The technostress creator-age relationship

The literature presents mixed findings regarding the relationship between technostress creators and age, thereby presenting a lack of consensus on the relationship between these variables (Berg-Beckhoff et al., 2017; Ozgür, 2020; Wang & Zhao, 2023). La Torre et al.'s (2019) systematic review of technostress antecedents concluded that a positive relationship exists between age and levels of technostress, which is consistent with Shu et al.'s (2011) and Fuglseth and Sørebø's (2014) findings. This aligns with Tu et al.'s (2005) findings that employees older than 35 years of age more likely to experience technostress than younger employees. They further found that this was particularly significant for techno-overload and techno-complexity sub-scales of the Technostress Creator Scale. Their findings were consistent with those of Marchiori et al. (2019), showing that older workers are more likely to experience technostress arising out of techno-complexity. Tu et al. (2005) suggested that older employees are more likely to be more rigid in their ways of thinking, and more used to conventional work settings and procedures, while also possessing an inherent resistance to the adaptation and changes required with the introduction of new workplace technologies. They further suggested that older employees experience greater technostress because their learning capacity decreases with age, causing them more difficulty to adapt to new technologies. This concurred with the findings of Verginne et al.'s (2022) conclusion that older teachers are more likely to experience higher levels of technostress. Similarly, Shu et al. (2011) and Ozgür (2020) identified a significant positive relationship between age and technostress.

In contrast, Ragu-Nathan et al.'s (2008) findings suggest that technostress decreases as age increases. This is explained by Tarafdar et al.'s (2011) suggestion that older professionals experience lower levels of technostress than younger professionals, despite the latter's greater level of familiarity with technology. They suggested that this was due to the likelihood that older workers are better able to handle all types of work-related stress, due both to their greater maturity, and due to their possession of greater levels of organisation-specific experience and enhanced understandings of how to assimilate ICT-associated stress effects into their work contexts. This is consistent with Ragu-Nathan et al.'s (2008) opinion that these lower levels of technostress in older employees is also likely to be related to their supervisor overall stress management skills, when compared to younger employees. These findings regarding the relationship between technostress creators and age in the literature informed the development of *Hypothesis 1*:

Hypothesis 1: Age-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.

2.5.4 The technostress creator-gender relationship

The literature (e.g., Ozgür, 2020) also presents inconsistent findings regarding the relationship between worker gender and technostress. Ragu-Nathan et al. (2008) showed that males scored higher than females on measures of technostress. In contrast, Vergine et al. (2022) showed that older female teachers have the highest overall levels of technostress. Asad et al. (2023) showed that the relationship between gender and technostress creators depends on the type of technostress creator. They showed that techno-overload and techno-invasion had higher means for female participants, while male participants scored more highly than female participants on measures of techno-complexity, techno-uncertainty and techno-insecurity. This agreed with Aktan and Toraman's (2022) finding that male teachers experienced significantly higher levels of techno-insecurity-related stress than female teachers did. Asad et al.'s (2023) findings further concurred with La Torre et al.'s (2020) findings showing that females are more likely to experience higher levels of techno-overload and techno-invasion, but contrasted with their conclusion that females also experience higher techno-complexity scores. Similarly, Marchiori et al. (2019) concluded that women are more likely to experience higher levels of techno-complexity. Marchiori et al.'s (2019) contrast with those of Asad et al. (2023), showing that male workers are more likely to experience technostress arising from techno-overload and techno-invasion, while women score higher on levels of techno-uncertainty. These findings regarding the relationship between technostress creators and gender in the literature informed the development of *Hypothesis 2*:

Hypothesis 2: *Gender-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.*

2.5.5 The technostress creator-education relationship

The literature is also inconsistent about the findings of the relationship between level of formal education and technostress. According to Ragu-Nathan et al. (2008), professionals with higher levels of formal education are more likely to have been exposed to more ICTs in general while acquiring their qualifications. This prior familiarity with technology reduces their ICT-related anxiety, while also promoting their adaptability to technostress. However, Wang et al. (2008), Shu et al. (2011) and Marchiori et al. (2019) showed no level of education-related differences in the level of technostress experienced. These findings in the literature about the relationship between technostress and level of education formed the basis of *Hypothesis 3*:

Hypothesis 3: *Education-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity (f) techno-uncertainty in university lecturers.*

Participant age, gender and level of formal education were control variables in the testing of *Hypotheses 4* to *10*.

2.5.6 The technostress creator-work performance relationship

Employee performance is key to the success of an organisation (Saleem et al., 2021), such as a university. The relationship between technostress creators and work performance was explored in the development of this hypothesis. This thesis positioned technostress creators as job demands, with work performance as an organisational outcome within the Job Demands-Resources framework.

Work performance as used in this study represents a combined measure of both work task productivity and work task innovation. Performance is therefore considered to be the successful completion of work tasks (Jena, 2015). When referring to productivity within the context of information systems use, ‘productivity’ is often referred to as ‘task productivity’ (Upadhyaya & Vrinda, 2021). Torkzadeh and Doll (1999) define task productivity as the “…*the extent that an application improves the user’s output per unit of time*…” (p. 329). They further define task innovation as “…*the extent that an application helps users create and try out new ideas in their work*…” (p. 329). Measures of both productivity and innovation should be included when considering the relationship between technostress and work performance, because “…*innovation plays a major role in sustaining competitive advantage for an organization*.” (Dixit & Upadhyay, 2021, p. 163). The development of *Hypothesis 4* explored the direct relationship between technostress creators and productivity and innovation, combined into a measure of work performance. The exploration of this is significant in that optimal employee performance is necessary for an organisation to achieve its strategic goals (Jena, 2015).

Technology-associated stress affects work productivity, with the direction of this relationship dependent on the level of stress experienced. This stress-productivity relationship is individual to each worker. ICT use may initially promote increases in productivity, associated with a positive relationship between technology use and productivity levels. This positive relationship reaches an optimal level, representing the threshold at which the usability of ICTs in promoting productivity gains is surpassed, resulting in a negative relationship between technology overload and productivity (Karr-Wisniewski & Lu, 2010; Hung et al., 2015).

When considering the types of technostress creators and their relationship to work productivity, the literature shows that these positive and negative relationships between technostress and productivity are dependent on the type of technostress creator under consideration (Zhao et al., 2022). Tu et al. (2005) demonstrated a positive relationship between techno-overload and productivity, and negative relationships between techno-complexity, techno-insecurity and productivity, respectively. They further found the absence of a significant relationship between the overall level of technostress, techno-complexity and techno-uncertainty levels, and productivity, respectively. Similarly, Li and Wang's (2021) study on techno-stressor's effects on university teachers' work performance demonstrated a positive association between techno-overload and work performance, while also showing a negative relationship respectively between techno-complexity and techno-insecurity and work performance. In contrast, Tarafdar et al. (2007) demonstrated a negative relationship between the overall measure of technostress and task productivity, and task innovation, respectively of US public sector workers. A similar inverse relationship was shown between technostress creators and end-user performance, representing both innovation and productivity (Tarafdar et al., 2011) and Tarafdar et al. (2015). Tarafdar et al. (2011) showed a negative relationship between techno-overload, techno-invasion and techno-complexity, respectively, and task productivity. Similarly, Qi (2019) demonstrated that increased levels of technostress creators are associated with reduced academic performance of students, particularly for the techno-complexity and techno-invasion measures. Similarly, Upadhyaya and Vrinda (2021) demonstrated a negative technostress-task productivity relationship between each of the technostress creators and task productivity in Indian university students. Yener et al.'s (2021) study of technostress experiences of Turkish civil servants also showed that technostress affected both task and contextual work performance in a significant, negative, way. Tams et al. (2020) explains that the loss of productivity associated with ICT use for work is likely to be associated with the frequent interruptions that such technologies facilitate, leading to reduced engagement with these technologies. Overall, these findings demonstrate a predominantly negative relationship between technostress creators and measures of work performance, thereby informing the formulation of *Hypothesis 4.*

Hypothesis 4: *The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty negatively predict work performance in university lecturers.*

These hypothesised relationships are demonstrated in *Figure 2.2,* positioning technostress creators as predictor (X) variables, with work performance as the outcome (Y) variable.

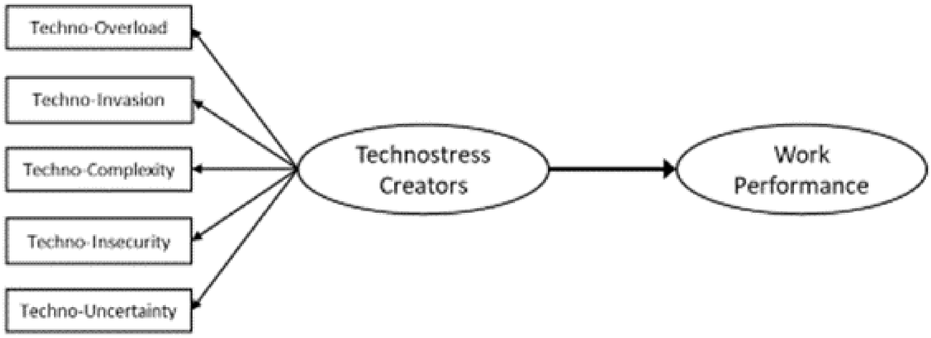

Figure 2.2 Hypothesised relationship between technostress and work performance

2.5.7 The technostress creator-work-related burnout relationship

The potential for the manifestation of burnout related to occupational settings has been recognised by the World Health Organisation's (WHO) classification of burnout as an occupational phenomenon in latest revision of the International Classification of Diseases (WHO, 2019). Schaufeli and Greenglass (2001, p. 501) define burnout as *"..a state of physical, emotional and mental exhaustion that results from long-term involvement in work situations that are emotionally demanding"*(p. 501). Exhaustion and fatigue are widely recognised as components of work-related burnout (e.g., Maslach et al., 2001; Kristensen et al., 2005; Panisoara et al., 2021; Pijpker et al., 2022). Exhaustion, fatigue and burnout were therefore considered to be synonymous for the purposes of this study.

Burnout is a chronic condition. Over time, it may lead to adverse physical, psychological and/or occupational consequences. Physical effects may include musculoskeletal pain, reduced energy levels, Type 2 diabetes, headaches, respiratory and gastrointestinal issues. Negative psychological effects may manifest as insomnia, depression, anxiety, substance abuse, depersonalisation and a sense of reduced personal accomplishment and a poor sense of self-efficacy. Adverse occupational effects may result in absenteeism, reduced job performance, lower levels of job satisfaction, (Maslach et al., 2001; Alarcon et al., 2011; Salvagioni et al., 2017; Bakker et al., 2023), reduced organisational commitment (Bakker et al., 2003) and increased turnover intention (Schaufeli & Bakker, 2004).

Califf and Brooks (2020) maintained that there was a dearth of empirical research into the relationship between techno-stressors and burnout. The influence of technostressors on worker well-being has not been widely studied (Hang et al., 2022). Yener et al. (2021) suggest that there is an ongoing debate in the literature about the nature and extent of the relationship between technostress and burnout. Berg-Beckhoff et al.'s (2017) systematic literature review on the relationship between work-associated technology usage and burnout recognises that ICT users may at times evaluate technostress creators as opportunities, instead of threats, resulting in positive individual and organisational outcomes. However, their predominant conclusion was that a positive relationship exists between work-associated technology usage and burnout. This conclusion has since been supported by the findings of later studies in this domain (e.g., Pflügner et al., 2021; Yener et al., 2021; Kasemy et al., 2022; Zhao et al., 2022). Consistent with the dominant perspective in the literature, the emphasis on this study described here is on the negative evaluations that ICT users have of technostress creators and the burnout associated with this.

The role of organisational demands and resources and their role in the burnout experiences of academic staff have been recognised in the literature (e.g. Watts & Robertson, 2011; Lackritz, 2014; Visotskaya et al., 2018; Redondo-Flórez et al., 2020), consistent with the expectation that those working in human services areas are likely to suffer from higher levels of burnout (Rothman & Barkhuizen, 2008; clarheim et al., 2022). It has been proposed that burnout arising from the experience and expectation of using digital technologies in academic workplaces arises from global changes in curriculum design and technology, contributing to the job demands perceived by academics (Amer et al., 2022). Ongoing attempts at coping with this technostress, coupled with the failure of these attempts due to lack of resources, can lead to burnout of HEI employees (Salanova et al., 2014).

The literature therefore supports the positioning of ICT as a situational characteristic used for educational and administrative purposes in HEIs within the Job Demands-Resources framework as a job demand, negatively influencing the well-being of academic staff through the manifestation of work-related burnout, consistent with the health impairment process of this framework. This positioning informed *Hypothesis 5*:

Hypothesis 5: The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty positively predict work-related burnout in university lecturers.

These hypothesised relationships are demonstrated in *Figure 2.3*. This positions technostress creators as predictor (X) variables, with work-related burnout as the outcome (Y variable).

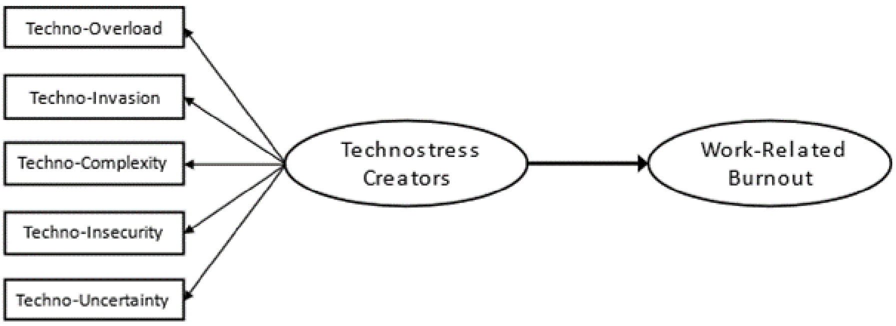

Figure 2.3 Hypothesised relationship between technostress creators and work-related burnout

2.5.8 The work-related burnout-work performance relationship

Possible consequences of burnout of academic staff in HEIs include negative changes in physical and mental health, low morale, drug and alcohol abuse, impaired interpersonal relationships, declining teaching and research performance, increased absenteeism and increased turnover intention (Rothman & Barkhuizen, 2008). These consequences of the burnout experienced by academic staff may manifest as a reduced ability to respond to students' needs, which is likely to negatively impact on student well-being and performance, ultimately leading to reduced effectiveness of the educational process and student satisfaction (Rothman & Barkhuizen, 2008; Amer et al., 2022). This illustrates the negative organisational impact of employee burnout (Bakker et al., 2023), as workers experiencing burnout will be unable to fulfil their duties and responsibilities to the satisfaction of their employers (Yener et al., 2021).

The development of *Hypothesis 6* explored the direct relationship between work-related burnout and work performance. A negative relationship between burnout and work outcomes is supported by Borle et al.'s (2021) systematic review findings. Amer et al.'s (2022) study concludes that reduced job performance is recognised as a consequence of burnout in university occupational settings. These findings informed the development of *Hypothesis 6*:

Hypothesis 6: Work-related burnout positively predicts work performance in university lecturers.

These hypothesised relationships are demonstrated in *Figure 2.4*. This positions work-related burnout as the predictor (X) variable, with work performance as the outcome (Y) variable. This hypothesises that a negative individual level outcome will also result in a reduced outcome at an organisational level.

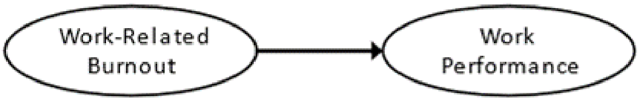

Figure 2.4 Hypothesised relationship between work-related burnout and work performance

2.5.9 Burnout as a mediator of the technostress creator-work performance relationship

While *Hypotheses 4, 5* and *6* explore the relationships between technostress creators and work performance, technostress and work-related burnout, and work-related burnout and work performance, *Hypothesis 7* as proposed here combines these relationships into a single, simple mediation model. Bakker et al. (2004) showed that exhaustion partially mediated the relationship between work demands and job performance, while Tarafdar et al. (2007) suggested that ICTs may lead to burnout and reduced work productivity. Although Yener et al.'s (2021) study showed that burnout mediated the relationship between technostress and task performance, and work performance, respectively, this mediation effect was not found to be statistically significant. These findings in the literature positioning burnout as a mediator along the performance pathway informed the development of *Hypothesis 7*. The direction of mediation as indicated here is consistent with the Job Demands-Resources model, which positions burnout as an outcome of job demands, as represented by workplace technologies and resultant technostress in this study. Similarly, the positioning of work performance as an outcome of both technostress arising from either job demands, or burnout, or both combined, where burnout functions as a mediator, is also consistent with the direction of mediation in the Job Demands-Resources model, which positions organisational outcomes such work productivity as consequences of both job demands, and employee health impairment, as represented by burnout (Demerouti et al., 2001).

Hypothesis 7: *Work-related burnout partially mediates the relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.*

These hypothesised relationships are demonstrated in *Figure 2.5*. This positions technostress creators as the predictor (X) variables, with work performance as the outcome (Y) variable and work-related burnout as the mediator (M) variable. This hypothesis therefore suggests that the negative relationship between technostress creators and work performance can be explained by work-related burnout.

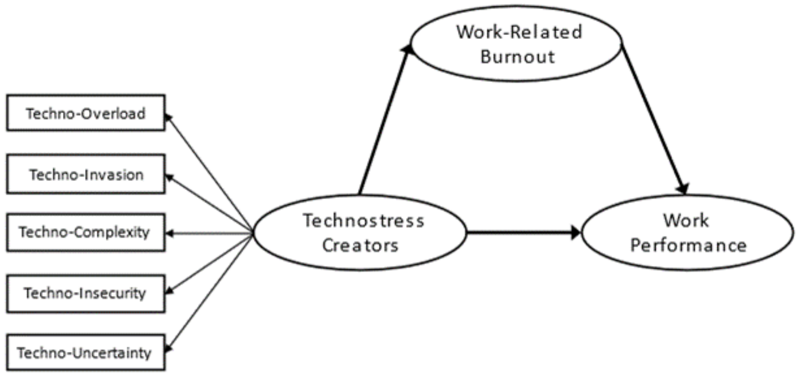

Figure 2.5 Hypothesised role of work-related burnout as a mediator of the technostress-work performance pathway

2.5.10 Technostress inhibitors moderate the technostress creator-work performance relationship

Organisational mechanisms and job characteristics intended to reduce ICT-related stress experienced by workers in occupational settings are called technostress inhibitors. These inhibitors are considered as job resources within the Job Demands-Resources framework on the basis that they are assumed to interact with technostress creators in such a way as to reduce the negative individual and organisational-level effects of the technostress creators (Ragu-Nathan et al., 2008; Camacho & Barrios, 2022). Technostress inhibitors therefore function to protect employees from the negative impacts of technostress creators (Vergine et al., 2022), while leading to improved individual employee and organisational outcomes (Tarafdar et al., 2010). Li and Wang (2021) suggested that there is a need to further explore the role of technostress inhibitors in higher education settings, stating that "…*little is known regarding how specific technostress inhibitors affect specific technostress creators and how they create impact on university teachers' work performance in higher education.*" (p. 361). This supports the inclusion of technostress inhibitors in the study described here.

Ragu-Nathan et al. (2008) proposed three main technostress inhibitors: literacy facilitation, technical support provision and involvement facilitation. Each of these three mechanisms has the potential to reduce the effect of technostress creators on strain-related ICT outcomes for employees (Fugelseth & Sørebrø, 2014). This technostress inhibitor classification is most widely-adopted in the literature (Rohwer et al., 2022), as is evidenced by publications by Jena (2015), Hwang et al. (2021), Hang et al. (2022) and Pfaffinger et al., 2022), including more recently, in the higher education domain (e.g., Li & Wang, 2021; Mehrolia et al., 2021; Sharma & Gupta, 2022). La Torre et al. (2019) suggests that these inhibitors are the most important moderators of work-related technostress. Each of these inhibitors will now be described individually.

Literacy facilitation: This encompasses organisational training and learning initiatives emphasising digital literacy development, while also being responsive to the pace of technological change in occupational environments (Fuglseth & Sørebø, 2014; Atanasoff & Venable, 2017). Literacy facilitation mechanisms encourage and foster the sharing of ICT-related knowledge within the organisation (Ragu-Nathan et al., 2008). This may include knowledge sharing, teamwork, user training and user guides and other relevant documentation to enhance employee understanding of technologies and their applications, while developing skills appropriate to their use (Fuglseth & Sørebø, 2014; Atanasoff &

Venable, 2017). Literacy facilitation serves to reduce technostress by helping users to understand, and cope with, work-related ICTs and their uses (Ragu-Nathan et al., 2008). Tarafdar et al. (2010) suggested that literacy facilitators could offset the reduction in productivity associated with technostress creators, as these facilitators speed up learning, thereby reducing employee mistakes when using work-related ICTs. Similarly, Rasool et al. (2022) also recognised the importance of training employees on the use of new workplace technologies as a way of mitigating against technology overload in the workplace. Furthermore, Jena (2015) maintains that academic employees who have had sufficient ICT training are more positively predisposed to new workplace technologies than those who perceive that they have received insufficient training in these. The importance of effective training and updating of knowledge in facilitating teachers in using online learning and teaching tools is also promoted by Zheng et al. (2022).

Technical support provision: This is the organisational assistance and support to end-users of ICTs, such as university lecturers, by solving ICT users' ICT-related problems (Ragu-Nathan et al., 2008). These supports, such as IT help desks, serve to reduce workplace ICT-related stress (Fuglseth & Sørebø, 2014; Atanasoff & Venable, 2017). Tarafdar et al. (2010) suggested that technical support provision addresses the ICT-related problems experienced by employees, thereby reduced the techno-complexity and techno-uncertainty associated with using workplace ICTs. This support can also help resolve technical problems and mistakes disrupting critical processes, thereby mitigating against the loss of productivity that may arise due to these. Zheng et al. (2022) emphasised the importance of co-ordination between university management and IT staff for optimal planning and implementation of new technologies as a way of reducing technostress experiences of university teachers. This should also include the establishment of an online help desk for technical support provision to instantaneously solve ICT-related challenges as a way of reducing university teacher stress and enhancing their work performance.

Involvement facilitation: This encompasses the mechanisms used to involve and engage employees in their adoption of technological systems (Fuglseth & Sørebø, 2014; Atanasoff & Venable, 2017). Involvement facilitation helps to alleviate technostress through informing ICT users about the rationale for introduction of new ICTs, as well as their intended use and effects. This further encourages workers to engage with, and use, new ICTs (Ragu-Nathan et al., 2008). Sufficient time for workers to become familiar with new ICTs reduces the risk of technostress arising due to techno-complexity, while also gaining a sense of control over the introduction of these ICTs. This is likely to lead to a perception of the new ICTs as being less disruptive, leading to lower levels of techno-uncertainty (Tarafdar et al., 2010). Tarafdar et al. (2011) suggests that user involvement whereby ICT users are encouraged to learn and explore new ideas within the context of ICT use may result in increased productivity and innovation for ICT-related tasks. More recently, Borle et al.'s (2021) literature review recognised the importance of worker participation in workplace digitalisation processes, as a way of mitigating the negative effects of new workplace ICTs on worker's well-being.

The interactive effect of technostress inhibitors in mitigating against the negative effects of technostress creators is supported in the literature. For example, Hwang and Cha (2021) demonstrated a significant interactive effect between technostress creators and technostress inhibitors in predicting organisational commitment and compliance intention of security workers. Saleem et al. (2021) showed how training moderates the relationship between technostress creators and employee performance. As training is considered a literacy facilitator (Atanasoff & Venable, 2017), this supports this technostress inhibitor as a moderator in the technostress creator-productivity relationship.

Hypothesis 8 was based on a core assumption of the Job Demands-Resources, which is that the interaction between job demands and job resources should also be considered when investigating the influence of job demands on work performance (Demerouti & Bakker, 2022). This hypothesis positions technostress creators, as job demands, interacting with technostress inhibitors, as job resources, in predicting work performance as an organisational outcome.

Hypothesis 8: *The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.*

These hypothesised relationships are demonstrated in *Figure 2.6*. This positions technostress creators as the predictor (X) variables, with work performance as the outcome (Y) variable and technostress inhibitors as the moderator (W) variables. This hypothesis therefore suggests that the negative influence of technostress creators on work performance can be reduced by technostress inhibitors. This hypothesis therefore suggests that the combined interactive effect of technostress creators and technostress inhibitors will reduce the extent of the negative relationship between technostress creators and work performance.

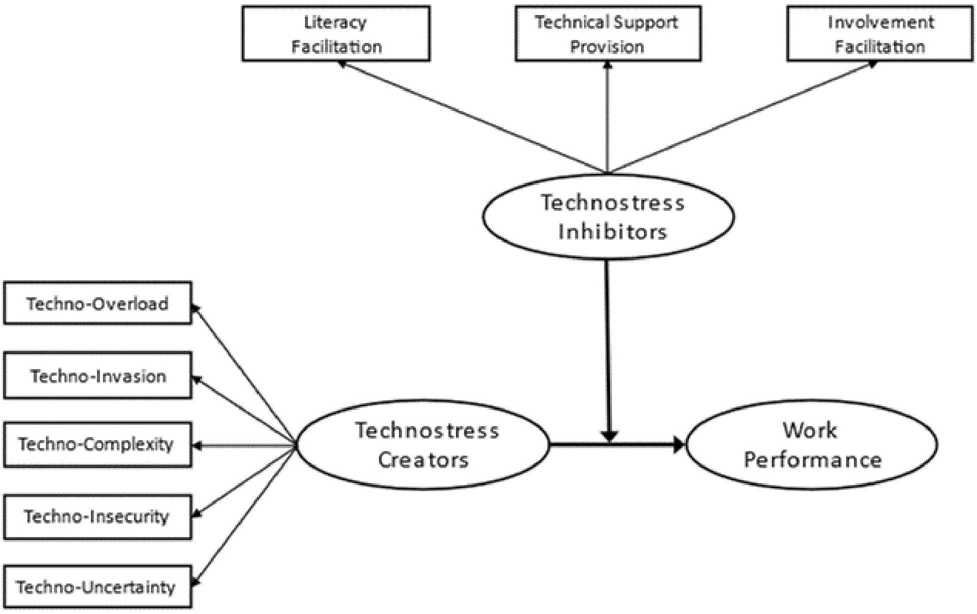

Figure 2.6 Hypothesised role of technostress inhibitors as moderators of the technostress creator-work performance pathway

2.5.11 Technostress inhibitors as moderators of the technostress creator-work-related burnout relationships

Pfaffinger et al. (2022) showed that technostress inhibitors moderate the relationship between technostress creators and detachment, and technostress creators and well-being. Hang et al. (2022) undertook a more detailed study into the interaction effects of technostress creators and technostress inhibitors in predicting employee well-being. They demonstrated the following significant interaction effects as being significant in predicting employee well-being: techno-overload x literacy facilitation; techno-invasion x literacy facilitation; techno-complexity x literacy facilitation; techno-insecurity x literacy facilitation. With regards to technical support provision, Hang et al. (2022) further demonstrated the following significant interactive effects in predicting improved employee well-being: techno-overload x technical support provision; techno-complexity x technical support provision. These results imply that technical support provision assists employees in solving their ICT-related problems. When exploring the role of involvement facilitation, Hang et al. (2022) demonstrated the following interactive effects negative influence employee well-being: techno-invasion x involvement facilitation; techno-insecurity x involvement facilitation. Hang et al. (2022) suggested that these findings of the interactive effects of involvement facilitation could be due to employees feeling over-involved in the procurement and testing of ICT, thereby leading to frustration and exhaustion. Their feelings of insecurity related to the introduction of a new system could be enhanced due to feeling that they lack the skills necessary to use the new ICT. These findings informed the development of *Hypothesis 9*.

Hypothesis 9: The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work-related burnout in university lecturers.

These hypothesised relationships are demonstrated in *Figure 2.7*. This positions technostress creators as the predictor (X) variables, with work-related burnout as the outcome (Y) variable and technostress inhibitors as the moderator (W) variables. This hypothesis therefore suggests that the combined interactive effect of technostress creators and technostress inhibitors will reduce the extent of the positive relationship between technostress creators and work-related burnout.

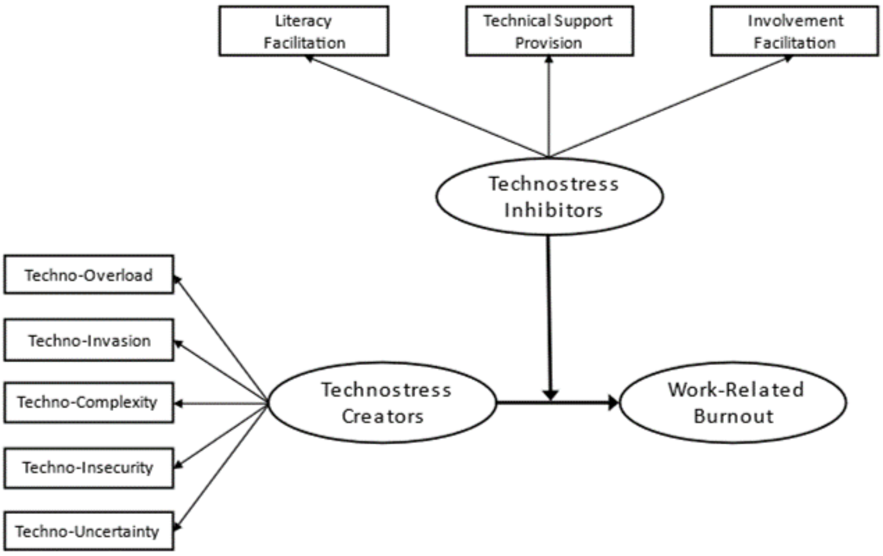

Figure 2.7 Hypothesised role of technostress inhibitors as moderators of the technostress creators-work-related burnout pathway

2.5.12 Moderated mediation model

There is a deficit in the literature exploring the combined effects of the relationships between technostress creators, technostress inhibitors, work-related burnout and work performance in a moderated mediation model. Pfaffinger et al. (2022) proposed that further studies on the relationship between technostress creators, technostress inhibitors, and employee well-being should investigate the interplay between variables within a moderated mediation model. *Hypothesis 10* was proposed to address this deficit.

Hypothesis 10: *The (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty is related to work performance through work-related burnout, with both the direct and mediated effects influenced by the (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision in university lecturers.*

The hypothesised moderated mediation model is summarised in *Figure 2.8*. This positions technostress creators as the predictor (X) variables, with work performance the outcome (Y) variable, and work-related burnout as the mediator (M) variable, while technostress inhibitors are the moderator (W) variables. This hypothesis involves the simultaneous and combined consideration of all of the relationships proposed in *Hypotheses 4* to *9*.

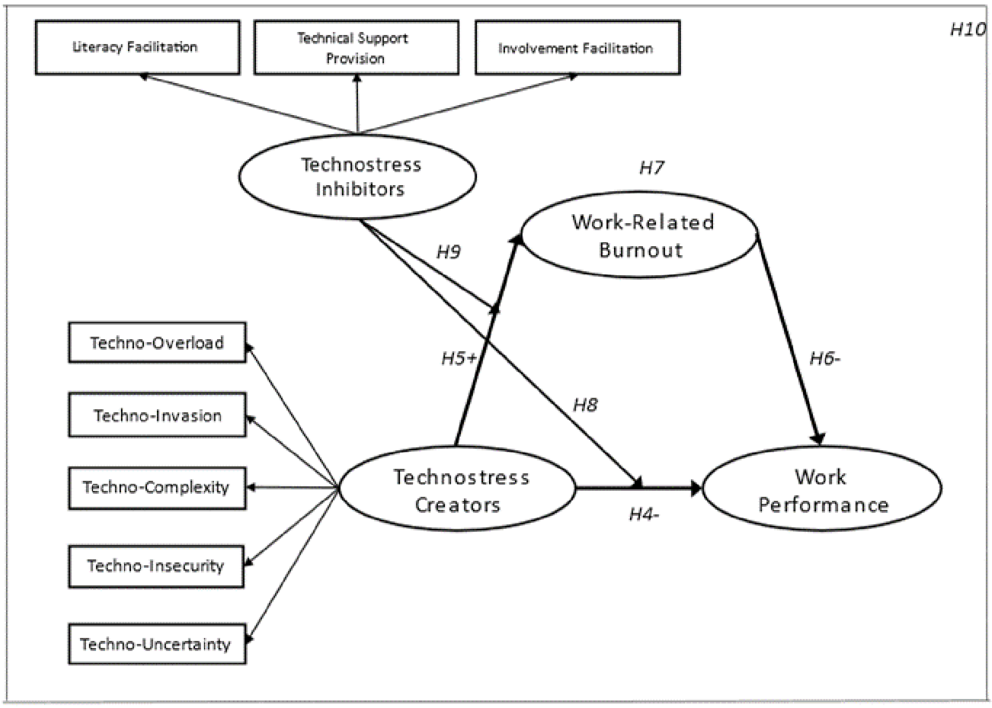

Figure 2.8 Hypothesised moderated mediation model

2.6 Summary of hypotheses

Table 2.1 below summarises the hypotheses for this study.

Hypothesis 1 (H1):	Age-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.
Hypothesis 2 (H2):	Gender-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.
Hypothesis 3 (H3):	Education-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity (f) techno-uncertainty in university lecturers.
Hypothesis 4 (H4):	The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty negatively predict work performance in university lecturers.
Hypothesis 5 (H5):	The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty positively predict work-related burnout in university lecturers.
Hypothesis 6 (H6):	Work-related burnout positively predicts work performance in university lecturers.

Hypothesis 7 (H7):	Work-related burnout partially mediates the relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.
Hypothesis 8 (H8):	The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.
Hypothesis 9 (H9):	The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work-related burnout in university lecturers.
Hypothesis 10 (H10):	The (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty is related to work performance through work-related burnout, with both the direct and mediated effects influenced by the (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision in university lecturers.

Table 2.1 Summary of Hypotheses

The methodology used to investigate these hypotheses is described in Chapter 3.

Chapter 3: Methodology

3.1 Overview

The quantitative cross-sectional survey-based research design used in this study is described here. Participants were university lecturers working in the Republic of Ireland universities sector. Data on participant experiences of workplace technostress creators, technostress inhibitors, work-related burnout and work performance were generated through participant self-report measures. This data was analysed using quantitative methods and mathematical models within an empirical-analytic paradigm (Cohen et al., 2018). Although designed primarily to collect quantitative data, three open-ended statements at the end of the questionnaire invited participants to share their thoughts on the advantages and disadvantages of the use of digital technologies in meeting their teaching, learning and assessment responsibilities. This data was analysed thematically and used to support the description and discussion of the quantitative data, while also identifying areas relating to the incidence and implications of technostress in higher education environments for further exploration into the future.

The research philosophy underpinning this thesis research is described first. This is followed by an outline of the ethics considerations governing this study. An overview of participant sample recruitment is then given, followed by a description of the questionnaire, and associated items, used as a measurement instrument in this study. Data collection, storage, retrieval and cleaning procedures are then outlined. This is followed by a description of the quantitative data analysis strategy adopted for the analysis of the constructs associated with the forced-choice questionnaire items, including the rationale behind the approaches taken. This section ends with an overview of the use of thematic analysis to analyse the responses to the open-ended statements at the end of the questionnaire, as these responses were used to inform the discussion of the quantitative analyses findings.

3.2 Research philosophy

Philosophy is the *"…study of the nature of knowledge and beliefs, the intelligibility of concepts, and the validity of arguments."* (Colman, 2015, p. 334). This section considers the foundation of the research approach taken for this thesis, as well as the researcher's beliefs about reality and beliefs about knowledge within that reality (Allison & Pomeroy, 2000). An inter-relationship exists between a researcher's ontological and epistemological positioning, their adopted theoretical stance, the methodology and methods used (Gray, 2021). *Figure 3.1* below draws on Gray's (2021) conceptualisation of the philosophical positioning of these inter-related components, summarising the ontology, epistemology, theoretical framework, methodology and methods adopted for this thesis research.

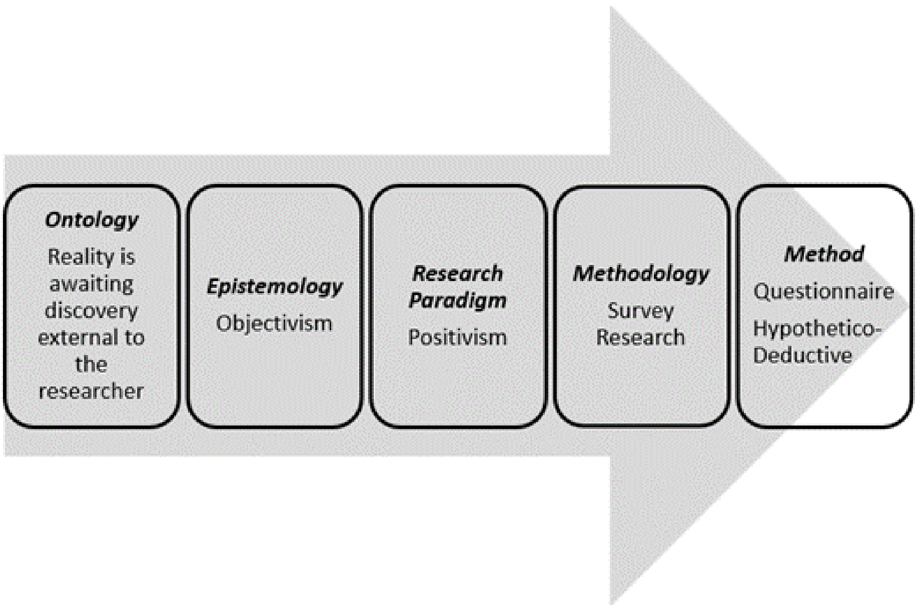

Figure 3.1 Research philosophy inter-relationships

Ontology

Ontology is a branch of metaphysics encompassing the study of the "…*nature of being or existence of the essence of things*…" (Colman, 2015, p. 306). It concerns the researcher's perception of the nature of the world and its reality (Cohen et al., 2018), centred on the question of "what it is to know" (Gray, 2021). This involves consideration of the filters through which the researcher views and experiences the world. The position of some researchers may be that an external reality is awaiting discovery, whereas others adopt the position that reality is socially constructed through the interaction of the researcher's internal self and their external world (Allison & Pomeroy, 2000). The ontological positioning adopted in the study described here is that reality is external to the researcher, awaiting to be discovered.

Epistemology

Epistemology is the nature of knowledge (Allison & Pomeroy, 2000), also considered as "what is means to know" (Gray, 2021). It is the "…*theory of knowledge, especially the enquiry into what is to count as knowledge, the validity of knowledge, what distinguishes mere belief from knowledge, what kinds of things are knowable, and whether anything can be known for certain."* (Colman, 2015, p.149). Epistemology therefore considers the sources of knowledge. The assumptions on which knowledge is based are questioned. The guiding questions are "what do we know?" and "what can be known?" (Allison & Pomeroy, 2000). The epistemological positioning in the study described here is that of objectivism. A researcher adopting an objectivist approach treats the social world like natural phenomena, which are real and external to the researcher (Cohen et al., 2018). The study described here is objectivist in that the inquiry aim involved explanation, prediction and control of variables in the verification of hypotheses for the establishment of facts (Allison & Pomeroy, 2000).

Research paradigm

Originally proposed by Kuhn (1962), a 'research paradigm' describes a way of looking at, or researching, phenomena. Regarded as the researcher's 'worldview', it describes a view of what is treated as commonly-accepted, or correct, scientific knowledge, informed by "…*a shared belief system or set of principles, the identity of a research community, a way of pursuing knowledge, consensus on what problems are to be investigated and how to investigate them,* *typical solutions to problems, and an understanding that it is more acceptable than its rivals."* (Cohen et al., 2018, p. 8).

Positivism claims that "…*science provides us with the clearest possible ideal of knowledge*" (Cohen et al,. 2018, p. 8). A positivist positioning uses methodological approaches commonly used in natural science research, applying them directly to the social sciences (Cohen et al., 2018). Positivism centres on the belief that reality exists only external to the researcher, investigated only through a rigorous process of scientific inquiry (Gray, 2021). This supports the use of empirical observation and explanation to understand behaviour, with findings explained using scientific conventions and descriptions. Analyses expected expressed as hypotheses or laws, allowing for generalisation from the findings of the observed phenomena (Cohen et al., 2018). The quantitative study described in this thesis is based on the philosophy that social phenomena can be researched empirically in similar ways to those methods used for the investigation of natural and physical phenomena. This is positioned in a positivist research paradigm, commonly associated with quantitative studies (Creswell & Guetterman, 2019).

Methodology

The methodology describes how the thesis topic was investigated and researched (Gray, 2021). The objectivist foundation of the methodology adopted in this study was that of an "…*abstraction of reality, especially through mathematical models and quantitative analysis*" (Cohen et al., 2018, p. 7). Allison and Pomeroy (2000) describe the characteristics of an objectivist methodology as being experimental, involving the verification of hypotheses using quantitative methods. A survey research methodology was adopted for the purposes of this study.

Method

A questionnaire was used as the main method to operationalise the methodology selected. The proposed use of a questionnaire to gather data about some of these psychological characteristics is consistent with the adoption of an objectivist position by social science researchers (Young, 2016). The predominantly quantitatively-oriented questionnaire was used as part of the broader hypothetico-deductive method adopted here to examine the existence, nature, and extent of relationships and associations between variables (Gray, 2021).

Ethical considerations relevant to this study are outlined next.

3.3 Ethical considerations

Ethics approval for this study was sought within the parameters and approval requirements of the Lancaster University Faculty of Arts and Social Sciences and Lancaster University Management School Joint Research Committee. Ethics approval for this study was also granted by the Technological University Dublin's Research Ethics and Integrity Committee. This research also conformed to the British Psychological Society's *Code of Human Research Ethics* (BPS, 2021) and *Ethics Guidelines for Internet-Mediated Research* (BPS, 2021). This includes participant informed consent, participant right to withdraw from the study, participant and university anonymity and security and anonymity of data storage, processing and presentation.

3.4 Participants

University lecturers employed by Irish[5] universities were invited to participate in this study. Data gathering was limited to a single national higher education (HE) environment, as Mudrak et al. (2018) have shown that inter-country differences in higher education governance may lead to academic staff in different countries having different perceptions and experiences of the job demands and job resources within their institutional and national higher education work contexts. This restriction of the study to one national context is also supported by Braunheim et al.s' (2022) finding of regional differences in technostress levels of workers, as well as Califf et al.'s (2020) suggestion that the appraisal of technologies as being stress-creating is associated with the workplace culture, which often is characteristic of a particular country or region.

Both convenience and snowball sampling are the two non-probability sampling approaches that were used to recruit study participants (Cohen et al., 2018). Convenience sampling, as one of the most common sampling strategies, involves securing access to the most easily accessible subjects (Gray, 2021). Snowball sampling involves the identification of a small number of individuals who have the participant characteristics relevant to the study. These people are then used as informants, identifying other people with the desirable characteristics (Cohen et al., 2018). In this study, convenience sampling was used to identify individuals with the main desirable participant characteristic: working as a lecturer in an Irish university. An invitation and link was then sent to these individuals. Snowball sampling was then adopted as these individuals were then asked to circulate the study invitation and link to others who they feel also met the main participant characteristic of working as a lecturer in an Irish university. These sampling approaches require the researcher to be actively involved in the initiation of the sampling. The main advantage of this sampling approach are that it is the least

[5] Republic of Ireland

costly sampling approach in terms of time, effort and money required to collect data (Gray, 2021).

Due to the pervasive usage of technology-facilitated and enabled teaching, learning and assessment in the Irish higher education system, particularly since the emergency remote teaching experience associated with the Covid-19 pandemic, it was assumed that all participants used computers for work, and were therefore considered capable of participating in an online survey. Despite this assumption, the initial email invitation to participate also invited participants to request a hard copy of the survey by post. However, no participants requested this hard copy version, as all preferred to complete the survey online.

3.5 Sample size

For the study described here, the minimum desired sample size for quantitative statistical analyses could not be determined using methods relying on knowledge of the overall size of the population under study, as the size of the population of university lecturers in the Republic of Ireland is not known.

Cohen et al. (2018) describes sample size recommendations from the literature, but closer review of the literature quoted failed to elicit a scientific, verifiable, consistent method for the sample size recommendations given. They also promoted consideration of the calculation of sample size based on the number of study variables, suggesting that the literature supported an acceptable sample size-to-variable ratio of between 5:1 and 30:1. When considering the four main constructs as the main variables in this study, adoption of this approach yielded an optimal study sample size of between 20 and 120 participants. Although this provides a useful overall frame of reference, I decided instead to follow Creswell and Guetterman’s (2019) recommendation of using a formula and statistical analysis procedures for a more precise estimate of the minimum desired sample size. The use of power analysis is considered a rigorous and systematic approach for calculating the minimum sample size necessary to detect an effect.

This includes consideration of the desired level of statistical significance, the amount of power and the effect size (Creswell & Guetterman, 2019; South et al., 2022).

Faul et al.’s (2009) freely-available statistical analysis programme, G*Power v.3.1.9.7, was used to undertake power analysis in this study. Developed by the Heinrich Heine Universität Düsseldorf, this software has been recommended for the use of sample size calculations in educational (e.g., Peng et al., 2012; Cohen et al., 2018; Chen & Liu, 2019; Creswell & Guetterman, 2019; Boyer-Davis, 2020; Kang, 2021) and psychological (e.g., Howitt & Cramer, 2017) research. The *a priori* analysis using G*Power as undertaken here is a method for controlling Type I and Type II errors, while proving hypotheses (Kang, 2021). The approach used here also aligns with Howitt and Cramer’s (2017) proposed steps for using G*Power to calculate sample size. The inputs of statistical significance, statistical power, effect size and predictors, which were required for determination of the ideal sample size for undertaking multiple linear regression analyses using G*Power are now briefly described. This is followed by a screenshot of the G*Power interface, showing the use of these inputs to calculate the desired sample size. Multiple linear regression was chosen here to calculate sample size, as it closely aligns with path analysis, which is central to the hypotheses proposed here.

Statistical significance: This indicates whether the occurrence of a particular statistical result was by chance, or not. It also indicates the probability of making a Type I error, occurring if the statistical test has erroneously detected an effect, without the presence of such an effect (a false positive effect) (Cohen et al., 2018). The statistical significance level is representative of the maximum allowable limit of Type I error (Kang, 2021). The test statistic is regarded as statistically significant if its *p*-value is smaller than the alpha level, which is typically set at $p = 0.05$ (Creswell & Guetterman, 2019), which is also the significance level used by Howitt and Cramer (2017) and Chen and Liu (2019).

This is also the default levels of significance used by IBM® SPSS® Statistics during statistical analyses (Cohen et al., 2018).

Statistical power: This is the ability of the statistical test to detect the presence of an effect, if such an effects is indeed present (Cohen et al., 2018). It is used to reject the hypothesis when the hypothesis is false. This suggests how much confidence can be placed in the results of a statistical analysis. Statistical power is typically set at 0.80 (Creswell & Guetterman, 2019; Chen & Liu, 2019). Although Howitt and Cramer (2017) suggested that this level might be too high for some psychological research, recommending instead a lower level, proposing that statistical power levels above 0.50 as viable. This concurs with the statistical power value of 0.95 was selected here, as this aligns with the 0.05 level of significance adopted.

Effect size: This is a measure of the magnitude of the relationship between two variables. In correlational analysis, the effect size is represented by the Pearson correlation coefficient (*r*), expressing the strength of the correlation between the two variables under measure (Howitt & Cramer, 2017). In regression analyses, effect size is represented by Beta (*β*), indicating how strongly the independent (predictor) variable influences the dependent variable. The effect size represents the probability of making a Type II error, which occurs when a statistical test erroneously neglects to detect an effect, when such an effect is present (a false negative effect) (Cohen et al., 2018). As there are no universally-accepted recommended settings for effect size when using G*Power to calculate sample sizes, I decided here to base the effect size selected for this calculation on Howitt and Cramer's (2017) classification of effect sizes associated with the Pearson's correlation coefficient (*r*). According to this classification, the 0.1 represents a small effect size, 0.3 represents a medium effect size and 0.5 represents a large effect size. I decided to adopt the 0.3 medium effect size as the effect size measure for these calculations, as this appears to represent the median effect size of the range of possible options.

Predictors: The variables associated with the testing of each of the hypotheses are stated in the literature review and hypotheses development section of Chapter Two. The independent (X) variable, also known as the predictor variable, is one of the inputs required for G*Power analysis, in that the total number of predictors must be entered in the software. Only the main constructs of technostress creators, technostress inhibitors, work-related burnout and work performance, were used when determining the number of predictors for entry into the G*Power programme. The total number of predictors associated with each of the study hypotheses are summarised in *Table 3.1*.

Hypothesis	Type of analysis	Predictors
Hypotheses 4-6	Linear regression analysis	*Predictor:* Technostress creator score.
Hypothesis 7	Simple mediation analysis	*Predictor 1*: Technostress creator score. *Predictor 2:* Combined effect of technostress creator and work-related burnout scores.
Hypotheses 8, 9	Simple moderation analyses	*Predictor*: Combined effect of technostress creator and technostress inhibitor scores.
Hypothesis 10	Moderated mediation model	*Predictor 1*: Technostress creator score. *Predictor 2:* Combined effect of technostress creator and work-related burnout scores. *Predictor 3*: Combined effect of technostress creator and technostress inhibitor scores.

Table 3.1 Hypothesis-related predictor variables

This demonstrates that the total number of predictors for testing these hypotheses ranges from 1 to 3. *Figures 3.2* and *3.3* show screenshots of the

G*Power software calculation for a predictor value of 3 and different effect sizes and powers. *Tables 3.2* and *3.3* below summarise the minimum sample size for a range of predictor values for these effect sizes and powers. *Table 3.2(a)* shows that the minimum desired sample size as calculated for linear multiple regression analyses undertaken in this study is between 46 (1 predictor) and 62 (3 predictors) when inputting an effect size of 0.30 and power of 0.95. Table 3.2(b) demonstrates a minimum desired sample size of between 55 (1 predictor) and 77 (3 predictors) when inputting an effect size of 0.15 and power of 0.80. These calculated sample sizes broadly align with the sample size range of 30 to 300 for quantitative statistical analysis, as presented in the literature review by Cohen et al. (2018) for educational research. According to Norman (2010), the literature on assumptions of parametric statistics do not support a restriction on sample size, demonstrating that this type of analysis is appropriate to a small sample size.

Linear multiple regression						
G*Power inputs	**Selection**					
Test family	F tests					
Type of power analysis	A priori: compute required sample size – given α, power and effect size					
Effect size	0.3					
Significance level	0.05					
Power	0.95					
Number of predictors	1	2	3	4	5	6
Desired minimum sample size	46	55	62	67	72	77

*Table 3.2 Sample size calculations using G*Power 3.1.9.7*

G*Power inputs	**Selection**					
Test family	F tests					
Type of power analysis	A priori: compute required sample size – given α, power and effect size					
Effect size	0.15					
Significance level	0.05					
Power	0.80					
Number of predictors	1	2	3	4	5	6
Desired minimum sample size	55	68	77	85	92	98

*Table 3.3 Sample size calculations using G*Power 3.1.9.7*

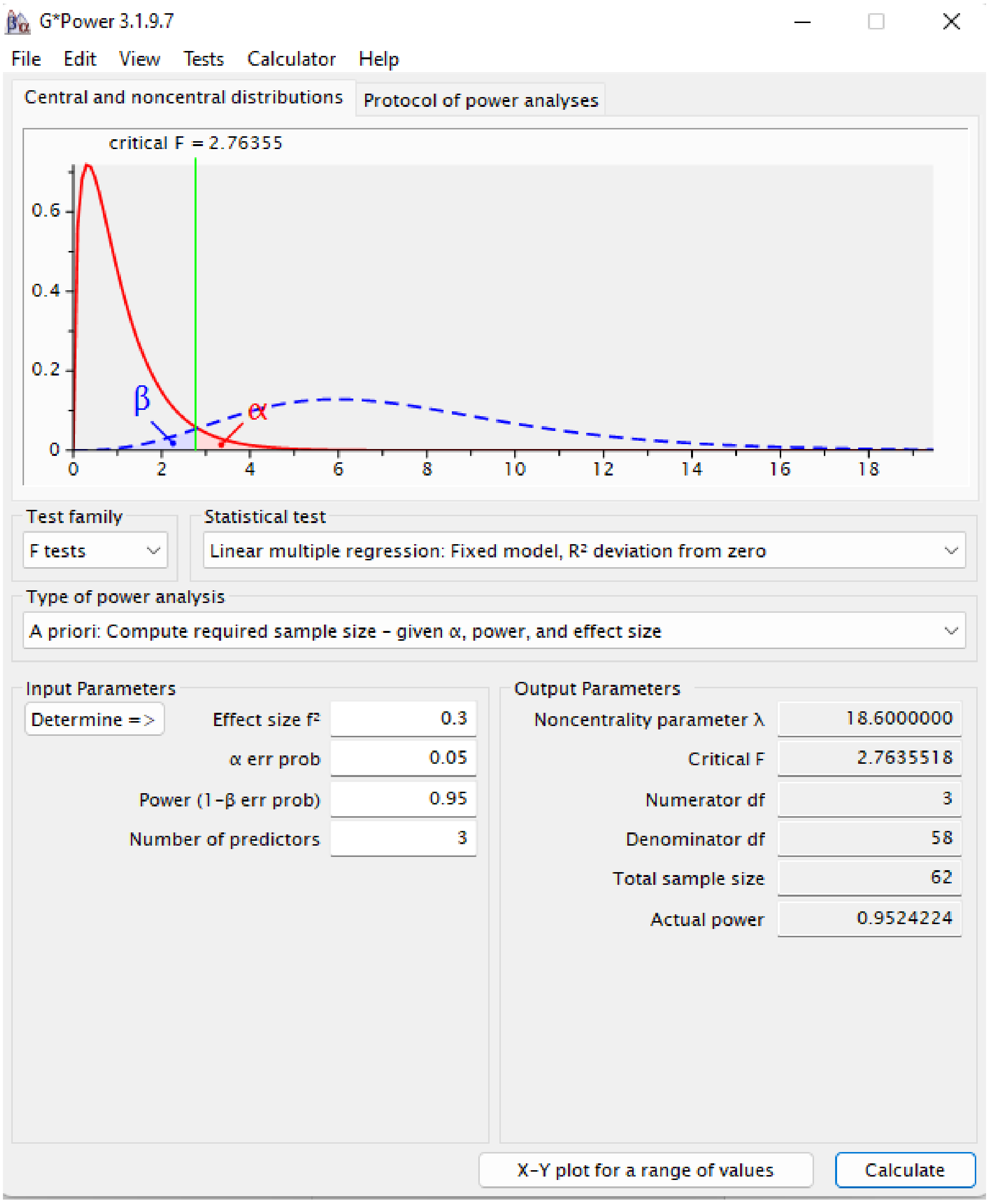

*Figure 3.2 Screenshot of G*Power sample size calculation*

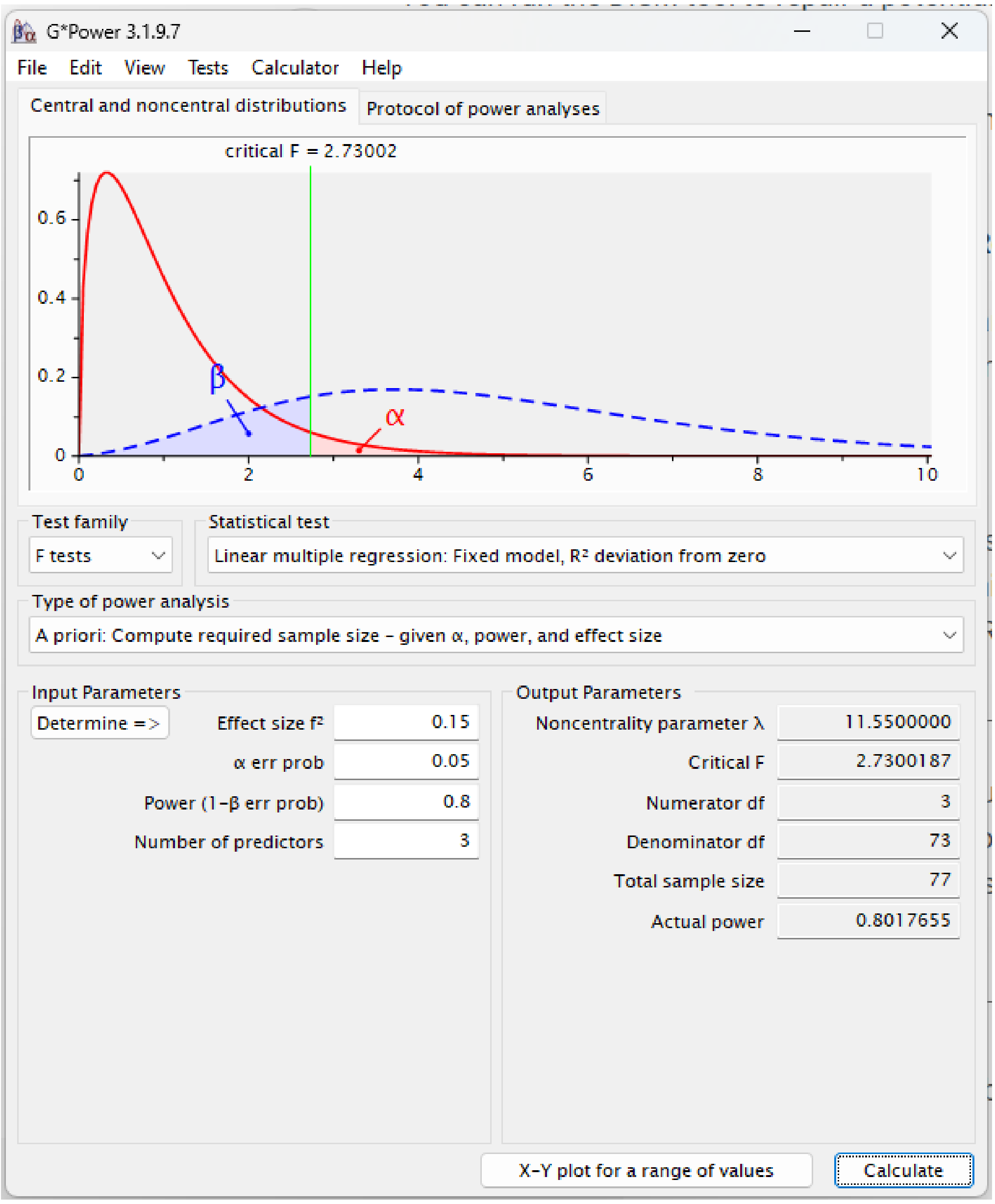

*Figure 3.3 Screenshot of G*Power sample size calculation*

3.6 Measurement instrument

An electronically-delivered questionnaire was developed as the measurement instrument to collect data in this study. The survey was compiled and distributed electronically. The advantages of such a cross-sectional study are that faster, more cost-effective data collection is facilitated (Berg-Beckhoff et al., 2017). This section commences with an overview of the questionnaire structure. This then followed by a more detailed description of each of the survey items and associated constructs included in this study.

3.6.1 Questionnaire structure

The questionnaire (Chapter 8) consisted of a title page and four main sections as described here.

Title page: This page included an invitation to participate in the study, overview information about the study, an ethics statement and contact details for the principal researcher. To reduce the possibility of social desirability bias influencing participant responses, the title page included an assurance that the anonymity of the respondents would be maintained.

Section 1: This constituted the participant consent form. Answers to Section 1 questions were compulsory to proceed with the remainder of the questionnaire.

Section 2: This section captured demographic information (age, gender) and work-related information (highest level of education, employment contract, number of years working as a lecturer in a university).

Section 3: This section consists of questions associated with the main study variables. This consisted of 39 items (questions), each in the form of a statement. Participants were asked to make forced-choice responses to items on a Likert scale. This multi-item, composite, scale used in this study allows for the measurement of the following constructs (latent variables): technostress creators (21 items); technostress inhibitors (7 items); work-related burnout (6 items); work performance (5 items).

'Item' is used here to refer to each of the questions included in the questionnaire. 'Construct' refers to a latent variable that is not directly measured. It is instead synthesised as the means from participant responses to the individual questionnaire items. The test items associated with each construct represent related concepts (Colman, 2015). As demonstrated in Chapter Two, constructs therefore need to be clearly-defined to facilitate a common conceptual understanding and communication of the phenomena being measured. The term 'sub-construct' is also used in this study to refer to the types of technostress creators (techno-overload, techno-invasion, techno-complexity, techno-insecurity, techno-uncertainty) and inhibitors (literacy facilitation, technical support provision, involvement facilitation), as these were also synthesised as the means of a cluster of defined test items. Questionnaire sections and questions were not explicitly labelled with descriptive titles to avoid answering bias associated with the connotations that the titles of the individual surveys may elicit (Schaufeli et al., 2006).

Section 4: This final section of the questionnaire consisted of three open-ended statements. These invited participants to describe perceived benefits and disadvantages of using digital technologies in higher education workplaces. The final question in this section provided participants with the opportunity to contribute additional insights into their experiences of using these work-related technologies. The purpose of these three questions were to gather data not directly captured through the forced-choice Likert-type questions in *Section 3*.

No identifying information was requested of participants. Participants were further reminded to complete the survey anonymously, without including any information that could identify either themselves or their employer institution in their survey responses (BPS, 2021; Saleem et al., 2021).

Table 3.4 below summarises the constructs and sub-constructs measured by the items in *Section 3* of the questionnaire. The measurement scales and associated items were selected on the basis that they have proven validity in the literature, as well as having been used in recent publications within the higher education and/or psychology domains. References associated with the authors and use of the selected measurement items and scales are also provided.

Construct	Sub-construct	Measurement scale	Reference
Technostress Creators	Techno-overload Techno-complexity Techno-invasion Techno-insecurity Techno-uncertainty	Technostress Creator Scale	Tarafdar et al. (2007)
Technostress Inhibitors	Literacy facilitation Technical support provision Involvement facilitation	Technostress Inhibitor Scale	Ragu-Nathan et al. (2008)
Work-Related Burnout	Work-related burnout	Copenhagen Burnout Inventory (CBI)	Kristensen et al. (2005)
Work Performance	Task productivity Task innovation	Task productivity Task innovation	Tarafdar et al. (2007) & Tarafdar et al., (2011); Tarafdar et al. (2015); Upadhyaya & Vrinda's (2021) adaptation of Torkzadeh & Doll's (1999) scale

Table 3.4 Measurement constructs, sub-constructs, scales and supporting references

Items relevant to this study were selected from the measurement scales in *Table 3.4.* Selective inclusion of such items also served the purposes of reducing the overall length of the questionnaire, in anticipation of this enhancing participant engagement with the questionnaire. The items were reworded slightly for the purposes of alignment with this study.

The control variables in this study were: age, gender and level of education. The predictor, outcome, mediator (where relevant) and moderator (where relevant) variables were clearly stated in Chapter 2.

A description follows of each of the measurement scales, as well as the constructs and sub-constructs that they are associated with.

3.6.2 Technostress creators

Tarafdar et al. (2007) developed the Technostress Creator Scale as a diagnostic tool for the evaluation of the presence and extent of technostress experienced by employees in organisations. The validity of this scale and its constituent items has been confirmed in the literature (e.g., Tarafdar et al., 2007; Ragu-Nathan et al., 2008). It has also been used to explore the effects of technology on employees in a variety of occupational settings (e.g., Wang et al., 2008; Tarafdar et al., 2015; Hang et al., 2022; Andrulli & Gerards, 2023), including higher education (Jena, 2015; Boyer-Davis, 2020; Bonanomi et al., 2021; Gabr et al., 2021; Li & Wang, 2021; Saleem et al, 2021; Kasemy et al., 2022). According to La Torre et al.'s (2019) systematic review of definitions, symptoms and risks associated with technostress, Tarafdar et al.'s (2007) Technostress Creator Scale is the most widely-used measure of technostress in cross-sectional studies. The use of this measurement instrument in this range of publications, including higher education settings, provided the basis for its selection as being suitable for the measurement of technostress in the study described in this thesis. The Technostress Creator scale was selected for this study on the basis that it has been widely validated, including in higher education settings. A further advantage of this scale is that it recognises that technostress can arise from a number of different workplace characteristics, with each of the representative sub-scales being accompanied by a clear definition, facilitating a shared understanding and communication of participant reported experiences of the use of technologies to support teaching, learning and assessment in higher education work contexts.

Twenty-one Technostress Creator Scale items were included in this study, measuring the five technostress creators: techno-overload; techno-complexity; techno-invasion; techno-insecurity; techno-uncertainty. Participants were asked to rate their responses on a five-point Likert response scale (1=*strongly disagree* to 5=*strongly agree*). Scale items include "*I am forced by technology to work much faster"* and "*I feel my personal life is being invaded by work-related technology".* Permission to use the questions was assumed as the questions were published in Tarafdar et al. (2007) and are therefore considered to be in the public domain. Cronbach alpha values of 0.70 and above indicate scale reliability (Cohen et al., 2018). Alpha values of above 0.70 have been established in the literature (e.g., Tarafdar et al., 2007; Ragu-Nathan et al., 2008; Tarafdar et al., 2015; Li & Wang, 2021; Hang et al., 2022) for each of the five technostress creators, evidencing reliability of these sub-construct measurement scales.

3.6.3 Technostress inhibitors

The Technostress Inhibitor Scale (Ragu-Nathan et al., 2008) was used to measure the extent to which technostress inhibitors (job resource) mitigate against the negative effects of technostress (job demand). These questions have previously been adapted and used in a variety of occupational contexts (e.g., Tarafdar et al., 2010; Tarafdar et al., 2015; Hang et al., 2022; Pfaffinger et al., 2022), including the higher education domain (e.g., Jena, 2015; Li & Wang, 2021). The Technostress Inhibitor Scale was selected for this study on the basis that it has been validated in the literature, including in higher education settings. Furthermore, each of the sub-scales is clearly defined, facilitating a shared understanding and communication of participant reported experiences of the use of technologies to support teaching, learning and assessment in higher education work contexts.

Seven technostress inhibitor items were drawn from Ragu-Nathan et al. (2008). The three technostress inhibitors measured were: literacy facilitation; technical support provision; involvement facilitation. Participants were asked to rate their responses on a five-point Likert scale, from 1=*strongly disagree* to 5=*strongly agree*. Scale items include *“My employer university encourages knowledge sharing to help deal with new technologies”* and *“Our IT helpdesk is responsive to staff requests”*. Permission to include these question items in the questionnaire is assumed, as the questions were published in Ragu Nathan et al. (2008) and are therefore considered to be in the public domain. Cronbach alpha values of 0.70 and above have been established in the literature (e.g., Ragu-Nathan et al., 2008; Tarafdar et al., 2015; Li & Wang, 2021; Hang et al., 2022) for each of the three technostress inhibitors, evidencing reliability of these sub-construct measurement scales.

3.6.4 Work-related burnout

Five items of Kristensen et al.’s (2005) Copenhagen Burnout Inventory (CBI) designed to measure work-related burnout were included in this study. The personal burnout and client-related burnout components of the CBI were omitted from this study, as these did not align closely with the relationships investigated. Furthermore, Braunheim et al., (2022) suggested that the work-related section of the CBI is a better predictor of job stress than the other CBI sub-scales. This work-related component of the CBI measures the degree of physical and psychological fatigue related to work (Millfont et al., 2008). This has been validated and used in studies in occupational domains (e.g., Kristensen et al., 2005; Milfont et al., 2008; Singh & Singh, 2018), including more recently, in the higher education domain (e.g., Kumpikaitė-Valiūnienė et al., 2021; Thrush et al., 2021; Todorovic et al., 2021). This measure of work-related burnout was selected on the basis that it captures both the exhaustion and fatigue dimensions of burnout, and it was designed specifically to measure burnout in employees in the human service sector (Kristensen et al., 2005) .

Participants were asked to rate their responses on a five-point Likert scale, from 1=*strongly disagree* to 5=*strongly agree*. Scale items include *“I feel worn out at the end of the working day”* and *“My work frustrates me.”* Permission to use the questions is assumed as the questions were published in Kristensen et al. (2005) and are therefore considered to be in the public domain. Cronbach alpha values of 0.70 and above have been established in the literature (e.g., Kristensen et al., 2005; Milfont et al., 2008; Singh & Singh, 2018; Thrush et al., 2021; Todorovic et al., 2021; Pijpker et al., 2022) for this measure of work-related burnout, evidencing reliability of these sub-construct measurement scales.

3.6.5 Work performance

Five items representing both task innovation and task productivity were drawn from Torkzadeh and Doll’s scale (1999). While these authors recognised the two dimensions of task productivity and task innovation as two separate constructs, it is proposed here that these two dimensions be considered as a single construct of work performance for the purposes of this study, as has been done elsewhere (e.g., Tarafdar et al., 2011). These task productivity and task innovation items were selected for the purposes of this study as they were developed with the intention of measuring the perceived impact of technology on work (Torkzadeh & Doll, 1999).

Participants were asked to rate their responses on a five-point Likert scale, from 1=*strongly disagree* to 5=*strongly agree*. Scale items include *“Technology helps to improve the quality of my work.”* and *“Technology helps me create new ideas related to my work”.* Permission to use the questions is assumed as the questions were published in Torkzadeh and Doll (1999) and Tarafdar et al. (2007) and are therefore considered to be in the public domain. Cronbach alpha values of 0.70

and above have been established in the literature (e.g., Torkzadeh & Doll, 1999; Tarafdar et al., 2007; Deng et al., 2008; Alam, 2016; Upadhyaya & Vrinda, 2021) for both task productivity and task innovation measures.

3.6.6 Open-ended statements

Participants were asked to respond to the following three open-ended statements at the end of the questionnaire:

- Please describe what you perceive as the benefits (for the lecturer) of using digital technologies in a higher education workplace.
- Please describe what you perceive as the disadvantages (for the lecturer) of using digital technologies in a higher education workplace.
- Please share any other thoughts that you have concerning the use of digital technologies in your workplace and the impact that they may have on you and how you approach your work.

These were included in an attempt to elicit further information about the participant's perceptions of technologies for educational purposes. The questions were purposefully designed in such a way so as to not lead the participant, creating bias in the responses. The intention was to use the responses here to inform the interpretation and discussion of the findings of the analyses of the questionnaire data.

3.7 Data collection, storage, retrieval and cleaning

Data storage, collection, analysis, presentation and destruction complied with the interpretations of General Data Protection Regulation (GDPR, www.eugdpr.com) and the UK Data Protection Act 2018. To test the stated hypotheses and model, the questionnaire was distributed electronically to lecturers at universities within the Republic of Ireland between November 2022 and February 2023. Microsoft Office 365 Forms software, linked to the principal investigator's Technological

University Dublin employee Microsoft account, was used to both distribute the questionnaire and for the storage of participant responses. The questionnaire was only distributed in electronic format, via an electronic link circulated to a network of contacts in the Irish higher education system. The Microsoft Forms software settings were selected to ensure that participants, and their employer universities, could not be identified through the data collection process. Participant responses were also stored within the MS Forms software. Upon completion of data collection, survey data stored in MS Forms was downloaded into MS Excel, where data was cleaned. This cleaning of the data involved the removal of incomplete data sets where responses were omitted to some of the items measuring the constructs under investigation. This cleaned data was then imported into IBM® SPSS® Statistics V.28 for further analysis. Data was computed in an aggregated manner, ensuring that it was not possible to identify participants based on their personal or employment information, or other responses. All software used was licensed to TU Dublin, with its use associated with the researcher’s TU Dublin staff account.

3.8 Quantitative data analysis strategy

The steps followed in undertaking the quantitative analysis of data are outlined in *Figure 3.4*.

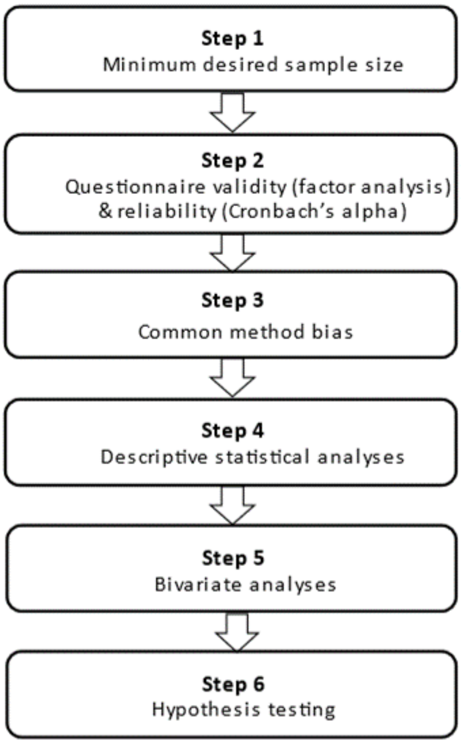

Figure 3.4 Steps followed for quantitative data analysis

In testing the hypotheses, the analyses were undertaken for the overall measure of technostress creators and technostress inhibitors, respectively, while also analysing the effects of their sub-constructs. This was deemed to be necessary, because the sub-constructs relate to different aspects of technostress creation and inhibition. This is supported by Chandra et al. (2019), who maintained that there are conceptual differences between individual technostress creators, requiring separate examination of each sub-construct measure for a more nuanced theoretical understanding of these creators and their relationships with other variables in the work environment.

3.8.1 Overview

The study described here was predominantly quantitative, using questionnaire data to evaluate research questions and associated hypotheses. The capturing of participant responses to open-ended statements at the end of the questionnaire did not constitute qualitative research but served to provide greater insights into the effects of technostress creators and inhibitors on work-related burnout and work performance of Irish university lecturers.

This section commences with a discussion of the rationale for undertaking parametric analyses of data generated through responses to Likert scales. This is followed by a description of the methods used to establish questionnaire validity and reliability, as well as to identify whether common method bias exists. Next follows a brief description of the descriptive and bivariate analyses undertaken. Statistical analysis applied during hypothesis testing is explained next. This includes one-way ANOVA testing, linear regression analyses, mediation and moderation analysis, and moderated mediation analyses.

3.8.2 Parametric analyses of Likert scale data

Likert scales facilitate the collection of quantitative estimates of subjective individual responses to a series of questions, designed to elicit unobservable constructs, thereby producing numeric data that can be summarised and visualised (South et al., 2022). The literature lacks consensus on statistical analysis strategies suited to handling Likert-type dependent variables (Norman, 2010; Chen & Liu, 2021; South et al., 2022). The treatment of Likert scale data as both ordinal and interval data has been promoted in educational research (Creswell & Guetterman, 2019).

According to Cohen et al. (2018) and Chen and Liu (2021), the scores associated with Likert-type survey item responses represent ordinal (discrete) data, suited only to non-parametric analyses appropriate to non-normal data distributions. This approach is considered overly restrictive by Harpe et al. (2015), with Mircioiu and Atkinson (2017) suggesting instead that such limitation of Likert scale data to non-parametric analyses may lead to loss of information and depth of analysis, recommending instead that such data should be subject to parametric analyses. Interval scales require parametric statistical analyses, appropriate to normally-distributed data (Creswell & Guetterman, 2019; South et al., 2022). Creswell and

Guetterman (2019) further suggest that it has become common practice to treat Likert scales as rating scales, assuming the presence of equal intervals between response categories. This is consistent with Harpe et al.'s (2015) suggestion that items constituting a measurement scale should only be considered for analysis in their aggregated form. They further recommended that such aggregated rating scales can be treated as continuous data, suitable for analysis using parametric statistical analysis methods. They argue that the use of parametric analysis of Likert data is consistent with, and reflective of, the methods used to develop and validate many Likert scales, as these rely on the use of categorical variables as measures of underlying latent variables, treated as continuous variables.

The use of parametric analyses for Likert-type scales in education research is further supported by Chen and Liu (2021)'s review of education and related literature concluding that 86% of research articles using Likert-type data as a dependent variable applied parametric analysis methods to this data. This is consistent with Norman's (2010) analysis of the literature on statistical analysis approaches for such data. He concluded that parametric analyses are suitable for Likert-type data in educational research, and that the potential violation of normality in the application of such analyses to non-normally distributed data results in statistically robust analysis findings. South et al. (2022)'s recommendations concur with this in that they claim that parametric analyses of Likert data facilitates researchers in gaining statistical power without the violation of test assumptions. The literature therefore provides strong support, rationale and justification for the use of parametric analysis methods for the analysis of the Likert data generated in the study described here. All analyses were carried out using IBM® SPSS® Statistics V.28.

3.8.3 Questionnaire validity and reliability

Factor analysis – a measure of scale validity

Principal Component Analysis (PCA) was undertaken for each of the main measurement scales (technostress creators; technostress inhibitors; work-related burnout; work performance) to test their validity. This analysis groups together survey items that have something in common, reducing a set of items to a smaller number of underlying (latent) factors (Cohen et al., 2018), called 'constructs'. These represent clusters of values that have a high level of correlation with each other (Field, 2018), thereby confirming that these variables address the same underlying construct (Cohen et al., 2018). This facilitates the transformation of the original variables into linear components (Field, 2018).

Cohen et al.'s (2018) methodology for conducting factor analysis in IBM® SPSS® Statistics was used. The Direct Oblimin rotation was selected, as this should be used if the researcher believes that there may be correlations between factors (Cohen et al., 2018). The Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy, requiring many pairs of variables to be statistically significantly correlated, should yield a measure of 0.6 or higher for the data to be suited to the use of PCA. The Bartlett Test for Sphericity investigates the correlations between variables and should be significant ($p < 0.05$) (Cohen et al., 2018) to support the undertaking of PCA. Both the KMO measure and the Bartlett Test for Sphericity have been previously applied in factor analysis in published studies on technostress and burnout in workplaces (Güğerçin, 2020; Ingusci et al,. 2021), including in academic settings (Castelló et al., 2017; Upadhyaya & Vrinda, 2021). Field (2018) suggested that some flexibility exists in how these factor loading cut-offs are applied and that factor loading values of as low as 0.40 may be acceptable, with this value being adopted as the lower limit for this study. Question items that did not load onto a factor during validity testing were excluded from further analysis.

Cronbach's Alpha – a measure of scale reliability

The most common method of establishing internal scale consistency and reliability is to calculate the Cronbach alpha (α) value (Field, 2018). This gives a measure of the internal consistency of a scale, providing a coefficient of the inter-item correlations, which are correlations of each item with the sum of all other items (Cohen et al., 2018). Field (2018) and Cohen et al. (2018) recommended that an alpha value of 0.70, or above, reflects reliability of the measurement scale.

After the removal of the question items that failed to demonstrate loading onto a factor during validity testing, the alpha value was calculated in this study for all remaining construct and sub-construct measures in this study. Where the alpha value for a sub-construct measure was less than the 0.70 threshold, that sub-construct measure was excluded from further analysis. However, where the items of that sub-construct measure were considered as part of the overall construct measure, and the overall construct alpha value was greater than 0.70, these items were still included in the overall construct measure.

3.8.4 Common method bias

Self-reported surveys are considered a subjective measure, which may be prone to common method bias (Ayyagari et al., 2011). Also known as 'common method variance', it is potentially associated with biased correlations between variables (Andrulli & Gerards, 2023). This bias can arise out of a variety of personal and measurement instrument design-related factors. Harman's single factor test (Fuller et al., 2016) is the most commonly-used statistical measure of common method bias (Jordan & Troth, 2020). According to this test, common method bias is present if a single factor explains most variation of the indicator variables, suggesting that covariance among items is significant (Ayyagari et al., 2011; Zhao et al., 2020). Ayyagari et al. (2011) applied a threshold variance of 25%, while others, e.g. Fuller et al., (2016), Cao et al. (2020) and Andrulli and Gerards (2023) adopted a threshold of 50%, whereby variances exceeding this are considered a strong indicator of the presence of common method bias.

Analysis of the data was undertaken after the completion of the validity, reliability and common method bias calculations. Only data that met the threshold requirements for these calculation outcomes were progressed to the descriptive statistics stage of data analysis.

3.8.5 Descriptive analyses

Descriptive statistical analyses were undertaken to provide a summary of the main data features (Goodwin, 2008). Question items were organised into sub-construct measurement scales according to the factor loading results of the validity assessment of the data. A mean score was calculated for each of these question items, main constructs and sub-constructs. The use of a mean for further analyses is consistent with the same approach as used in previous studies (e.g., Tarafdar et al., 2007; Aktan & Toraman, 2022). This calculation of the mean resulted in a set of continuous/interval data for each of these measures. These mean scores were then used for testing the hypotheses.

3.8.6 Bivariate analyses

Bivariate analysis was undertaken to highlight the correlational relationships between pairs of variables (Cohen et al., 2018). The variables in this analysis were the mean construct and sub-construct measures. The Pearson product moment coefficient, *r*, is a measure of the association between variables, assuming a linear relationship exists between these variables. A value of close to 1 assumes a strong positive linear association between variables, whereas a value of close to -1 assumes a strong negative linear association between variables (Goodwin, 2008).

3.8.7 Hypothesis testing

This section commences with a summary of the statistical analyses associated with each of the study hypotheses (*Table 3.5*). This is followed by a description of the role of bootstrapping in these analyses, followed by an overview of the Hayes PROCESS macro, used for testing *Hypotheses 7* to *10*. A theoretical overview is then given of each of the types of analyses stated in *Table 3.5*. Participant age, gender and level of education were controlled for during these analyses.

Hypothesis	Statistical analysis method
Hypothesis 1	One-way ANOVA
Hypothesis 2.	One-way ANOVA
Hypothesis 3	One-way ANOVA
Hypothesis 4	Linear regression analysis
Hypothesis 5	Linear regression analysis
Hypothesis 6	Linear regression analysis
Hypothesis 7	Simple mediation analysis (Hayes PROCESS Model 4)
Hypothesis 8	Simple moderation analysis (Hayes PROCESS Model 1)
Hypothesis 9	Simple moderation analysis (Hayes PROCESS Model 1)
Hypothesis 10	Moderated mediation analysis (Hayes PROCESS Model 8)

Table 3.5 Statistical analyses methods for hypothesis testing

Bootstrapping

Bootstrapping, as applied in these analyses, has been shown as a useful and verifiable method for overcoming sample size limitations regarding statistical analyses. It estimates the properties of the sampling distribution, generating more reliable confidence intervals for the data set (Field, 2008). This is achieved through statistical resampling of data that estimates model parameters and standard errors from the measured sample (Preacher et al., 2007). This results in an artificial increase in the sample size to the extent that it is large enough for data distribution to assume only minor significance, by making fewer assumptions about the sample distribution of the indirect statistical effects (Field, 2018) than the Sobel method does (Hayes, 2015). Bootstrapping does not rely on assumptions of normality (Field, 2018). The use of bootstrapping in this study is further supported by the inclusion of this in studies by Bakker (e.g., Bakker et al., 2012), one of the architects of the Job Demands-Resources model. It has also been used in educational research in studying the well-being of educators within this model (e.g., Cao, et al., 2020; Han et al., 2020; Huang & Wang, 2022), as well as other studies on the relationship between technostress and employee well-being (e.g., Pflügner et al., 2021; Andrulli & Gerards, 2023). A bootstrap sample size of 1,000, as recommended by Preacher et al. (2007), was adopted here. A 95% confidence interval was applied. (Howitt & Cramer, 2017; Field, 2018).

One-way Analysis of Variance (ANOVA) analysis

One-way ANOVA analysis was used to calculate the statistical difference between means of groups of variables (Cohen et al., 2018; Field, 2018). The initial analysis identifies that differences exist between means being analysed, but does not identify these differences. A *post hoc* analysis was used to identify the variables that demonstrate a statistically significant difference in their means. The Tukey test is widely adopted as a post hoc analysis test, supporting its use in the analysis of data in this study (Cohen et al., 2018).

Hayes PROCESS macro

The Hayes PROCESS macro (https://www.processmacro.org/index.html) plugs into IBM® SPSS® Statistics (Hayes, 2018). This is considered a robust statistical method for undertaking regression analyses (Saleem et al., 2021), allowing for the combination of multiple mediation and moderation analyses within the same model (Hayes, 2018). This PROCESS macro has been increasingly reported in the literature reporting on studies of the influence of technostress on employees and organisational outcomes (e.g. Andrulli & Gerards, 2023), including educational research in Higher Education domains (e.g., Moke et al., 2018; Kennett et al., 2021; Maslacki et al., 2021; Saleem et al.,2021; Meshram et al., 2022; Tan & Prihadi, 2022). This was used for undertaking simple mediation analysis (*Hypothesis 7*), simple moderation analyses (*Hypotheses 8* and *9*) and moderated mediation analysis (*Hypothesis 10*) in this study.

Linear regression analysis

Linear regression analysis was carried out using IBM® SPSS® Statistics V.28. Where a statistically significant correlation is identified between two variables, linear regression analysis can be used to identify and quantify a predictive relationship between the variables (Cohen et al., 2018; Field, 2018). The dependent variable can therefore be predicted from the value of the predictor variable (Cohen et al., 2018). Linear regression thus assumes that the predictor has a linear relationship with the dependent variable (Howitt & Cramer, 2017), as shown in *Figure 3.5*. This direct relationship between these two variables is depicted by path *c*.

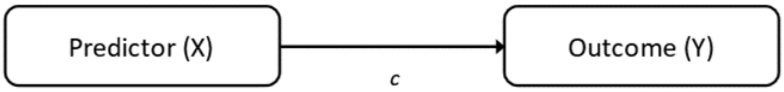

Figure 3.5 Linear regression model (after Field, 2018)

Simple mediation analysis

Simple mediation analysis, demonstrated in *Figure 3.6*, was used for the quantification and examination of direct and indirect pathways by which a predictor (X) variable had an effect on the outcome (Y) variable, through an intermediary, mediator (M), variable (Hayes, 2018). The mediator (M) variable was used to explain the relationship between the predictor (X) and outcome (Y) variables (Field, 2018). Simple mediation analysis was carried out using IBM® SPSS® Statistics V.28 with the Hayes PROCESS macro plug-in, facilitating the use of the Hayes PROCESS Model 4 for this analysis (Hayes, 2018).

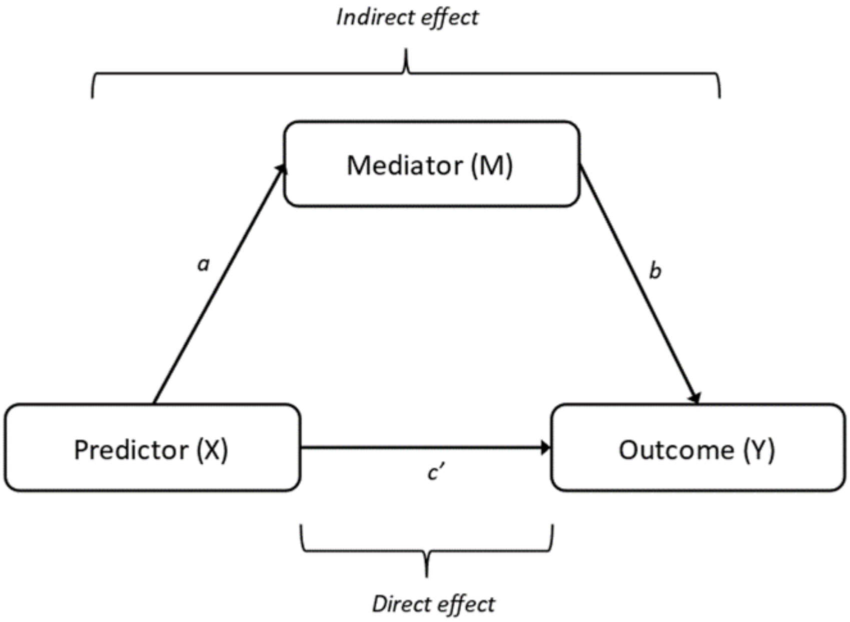

Figure 3.6 Simple mediation model (conceptual, statistical) (after Field, 2018; Hayes, 2018)

Path *c'* depicts the direct relationship between the predictor (X) and outcome (Y) variables. The indirect, mediated, relationship between these two variables can only be tested if the direct, linear relationship (path *c'*) is statistically significant. Next, a significant linear relationship must be identified between the predictor (X) and mediator (M) variables, as represented by path *a* (Field, 2018). The presence of a significant linear relationship between the mediator (M) and outcome (Y) variables must then be established, as represented by path *b* (Field, 2018). The 'direct effect' in *Figure 3.6* is represented by *Equation 3.1* below, while the 'indirect effect' is calculated using *Equation 3.2* (Hayes, 2018).

$$Direct\ effect\ of\ X\ on\ Y = c'$$

(*Equation 3.1*)

$$Indirect\ effect\ of\ X\ on\ Y\ through\ M = ab$$

(*Equation 3.2*)

The indirect effect of the predictor (X) variable on the outcome (Y) variable, through the mediator (M) variable must be significant to confirm the presence of a mediation effect of the mediator (M) variable (Field, 2018).

Simple moderation analysis

Simple moderation analysis was used for the examination of the effect of a predictor variable (X) on an outcome variable (Y), with this effect dependent on a third variable, the moderator variable (W) (Hayes, 2018). The moderator (W) variable influences the direction and extent of the relationship between the predictor (X) and outcome (Y) variables. Moderation is demonstrated when there is a significant interaction between the predictor (X) and moderator (W) variables in predicting the outcome (Y) variable (Field, 2018). Hayes PROCESS Model 1 is used to calculate whether a simple moderation effect exists (Hayes, 2018). The conceptual moderation model is shown in *Figure 3.7*, with *Figure 3.8* showing the statistical moderation model.

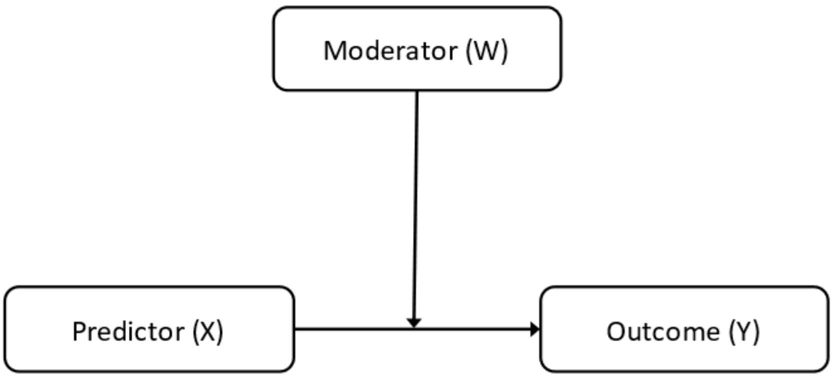

Figure 3.7 Simple moderation model (conceptual) (after Field, 2018; Hayes, 2018)

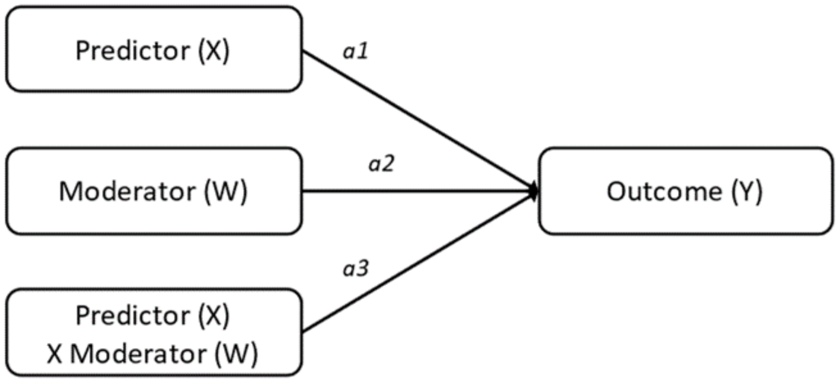

Figure 3.8 Simple moderation model (statistical) (after Field, 2018; Hayes, 2018)

There are three paths to consider in *Figure 3.8.* Path *a1* represents the direct effect of the predictor (X) variable on the outcome (Y) variable. Path *a2* represents the direct effect of the moderator (W) variable on the outcome (Y) variable. Path *a3* represents the interaction between both predictor (X) and outcome (Y) variables, thereby demonstrating whether a moderation effect is present or not. The moderation effect is calculated using *Equation 3.3* (Hayes, 2018):

$$Conditional\ effect\ of\ X\ on\ Y = b1 + b3W$$

(*Equation 3.3*)

The conditional effect of X on Y must be significant for a moderation effect to be confirmed (Field, 2018).

Moderated mediation analysis

Conditional process analysis forms the basis of moderated mediation analysis and is used *"…when one's research goal is to describe the conditional nature of the mechanism or mechanisms by which a variable transmits its effect on another and testing hypotheses about such contingent effects."* (Hayes, 2018, p.10) The Hayes PROCESS Model 8 was applied here to combine both moderation and mediation analyses into one overall model. In such an analysis, conditional process analysis *"…focuses on the estimation and interpretation of the conditional nature (moderation component) of the indirect/or direct effects (the mediation component) of X on Y in a causal system."* (Hayes, 2018, p.11). *Figures 3.9* and *3.10* demonstrate the conceptual and statistical moderated mediation model as applied to the data in this study.

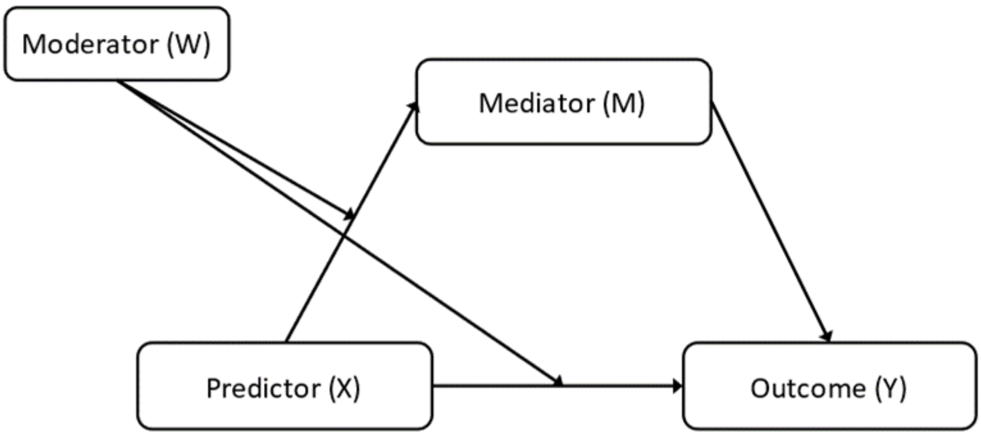

Figure 3.9 Moderated mediation model (conceptual) (after Hayes, 2018)

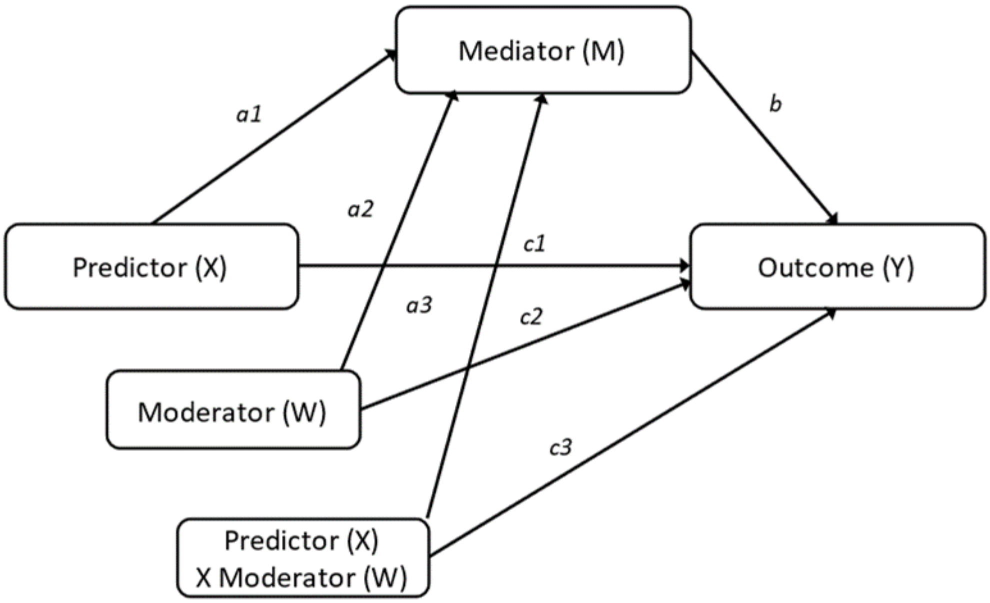

Figure 3.10 Moderated mediation model (statistical) (Hayes, 2018)

The indirect and direct mediated moderation effects were calculated using *Equations 3.4* and *3.5* (Hayes, 2018):

$$Conditional\ indirect\ effect\ of\ X\ on\ Y\ through\ M = (a1 + q3W)b$$

(*Equation 3.4*)

$$Conditional\ direct\ effect\ of\ X\ on\ Y = c1 + c3W$$

(*Equation 3.5*)

3.9 Open-ended statement data analysis strategy

The analysis of participant responses to the three open-ended statements at the end of the survey does not in itself constitute qualitative research, as the development of these questions was not informed by any particular qualitative research design. The intended purpose of these three questions was instead to gather narrative descriptions and participant insights into higher education workplace features that either promote or hinder them in using technologies for teaching, learning, assessment and administrative purposes. This information was used to both inform the discussion of the quantitative analysis findings of this study, as well as to identify future areas for research.

The narrative data generated through participant responses to these three questions were analysed using thematic analysis as proposed by Braun and Clarke (2022). This approach involves the identification, analysis and reporting of themes (patterns) within the data. A 'theme' is a category of information that captures important characteristics of the data in relation to the research question(s). Furthermore, it represents a way to generate a patterned response or meaning within a data set (Braun & Clarke, 2022). The use of thematic analysis to qualitatively analyse participant-generated data regarding the technology-related work experiences of higher education workers has been used in previous studies (e.g., Shankar et al., 2021; Govender & Mpungose, 2022; Naidoo & Chetty, 2022), further supporting its use in the participant responses generated in the study described here.

Themes in qualitative data analyses can be identified through either a deductive ('top-down') or inductive ('bottom-up') approach. A deductive approach is driven by a researcher's theoretical interest, and is undertaken with an analytical intention, providing a more detailed analysis of some aspects of the data. This is more appropriate when undertaking a thematic analysis to address a specific research question(s). The advantage of an inductive approach is that – similar to grounded theory - the themes are strongly linked to the data themselves. The thematic analysis is therefore data-driven, without having to fit into a pre-existing framework (Braun & Clarke, 2022). A hybrid thematic analysis approach was used here, incorporating both deductive and inductive consideration of data. The approach was predominantly deductive, in that data were analysed in alignment with themes representing the technostress creators and inhibitors and their sub-constructs. Themes aligning with both employee well-being (of which work-related burnout is a component) and work performance, including consideration of productivity and innovation, were also used to guide this deductive analysis.

The remaining data, deemed not in alignment with these pre-defined themes, were then analysed inductively. This inductive analysis was undertaken with the intent of identifying additional themes aligned to factors that should be considered when understanding the creation of technology-related stress and the organisational environment characteristics to mitigate against the negative effects of technology in higher education environments on both the individual lecturer and their work-related output. According to Xu and Zimmit (2020), the adoption of such a hybrid approach facilitates the *"…flexibility in discovering both descriptive meanings and interpretive meanings…"* (p. 7) that are relevant to the research questions. Xu and Zimmit (2020) promoted the use of such an approach as it draws on Braun and Clarke's principles of thematic analysis, while also allowing for flexibility in the course of practitioner inquiry in educational research.

The findings from the thematic analysis were used to theorise the significance of the patterns identified, while also considering their broader meanings and implications, as framed with reference to previous literature (Braun & Clarke, 2022). The inductive analysis findings were used to propose further areas of research regarding the use of technologies and their impact on those working in higher education settings.

The findings of the quantitative and qualitative analyses described here are summarised in Chapter 4.

Chapter 4: Results

4.1 Introduction

Seventy-nine respondents participated in the survey. Data from two participants were deleted during the data cleaning process due to the incompleteness of their data. The remaining seventy-seven responses (*N*=77) were analysed, constituting the participant sample for this exploratory study. This participant sample size was deemed to exceed the criteria for the minimum desired sample size of *N*=77, as calculated for three predictor variables, using G*Power 3.1.9.7 and the methodology described in Chapter 3, Section 3.5.

This section commences with a summary of participant characteristics. This is then followed by the outcome of the analyses relating to questionnaire validity, reliability and common method bias. Descriptive and bivariate analyses of questionnaire data is then presented. This is followed by analyses in support of hypothesis testing, including results of one-way ANOVA, linear regression, simple mediation, simple moderation and moderated mediation analyses.

4.2 Participant sample characteristics

The higher education experience of participants (*N*=77) ranged from 6 months to 34 years, with a mean of 14.02 ± 9.17 years. The demographic and occupational characteristics, and associated frequencies, of the participant sample are summarised in *Tables 4.1* to *4.4*. The data in *Table 4.1* shows that most (84.4%) of the participant sample were aged between 36 years and 55 years.

Age group	Frequency	%	Cumulative %
26-35 years	7	9.1	9.1
36-45 years	19	24.7	33.8
46-55 years	49	50.6	84.4
56-65 years	11	14.3	98.7
> 65 years	1	1.3	100.0
Total	77	100.0	

Table 4.1 Participant age frequencies

Table 4.2 shows that most (58.4%) of the participant sample identified as being female, with 39% of the sample identifying as male, with two participants not indicating alignment with either the female or male categorisation.

Gender	Frequency	%	Cumulative %
Female	45	58.4	58.4
Male	30	39.0	97.4
Non-binary	1	1.3	98.7
Prefer not to say	1	1.3	100.0
Total	77	100.0	

Table 4.2 Participant gender frequencies

Table 4.3 shows that most of the participants possessed a postgraduate degree, with 49.4% participants indicating that a Master’s degree as their highest level of qualification, while 44.2% indicated a PhD as their highest level of qualification.

Qualification Level	Frequency	%	Cumulative %
Honours degree	2	2.6	2.6
Post-graduate diploma	3	3.9	6.5
Masters degree	38	49.4	55.8
PhD	34	44.2	100.0
Total	77	100.0	

Table 4.3 Participant level of education

4.3 Questionnaire validity and reliability

Questionnaire validity and reliability were tested next to ensure that the questionnaire responses were both valid and reliable. Items not meeting the threshold for validity were omitted from further analyses.

4.3.1 Factor analysis – a measure of scale validity

The Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy score for all scale measures undergoing factor analysis exceeded 0.6, confirming the suitability of the data for principal components analysis. Similarly, the Bartlett Test for Sphericity for each measure was significant, which also supported the suitability of the data for undergoing PCA (Cohen et al., 2018). The factor loadings for each of the main constructs and associated sub-constructs measured are reported next.

Technostress Creator Scale

Table 4.4. summarises the factor loadings for the Technostress Creator Scale sub-scale items.

Sub-Scale	Item label	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Techno-overload (6 items)	To1	.907				
	To2	.806				
	To3	.900				
	To4	.543				
	To5	.564				
	To6 (Tv1)	.647				
Techno-complexity (4 items)	Tc1		.837			
	Tc2		.773			
	Tc3		.741			
	Tc5		.652			
Techno-insecurity (4 items)	Ti1			-.650		
	Ti2			-.803		
	Ti3			-.692		
	Ti4			-.705		
Techno-uncertainty (3 items)	Tu1				.824	
	Tu2				.800	
	Tu3				.566	
Techno-invasion (3 items)	Tv2					-.442
	Tv3					-.744
	Tv4					-.666

Extraction Method: Principal Component Analysis

Rotation Method: Oblimin with Kaiser Normalization

KMO = 0.779

Bartlett Test for Sphericity: p <0.001

Table 4.4 Factor loadings for the Technostress Creator Scale sub-scale items

The first item, Tv1, of the techno-invasion subscale loaded onto the same factor as the techno-overload. Item Tv1 was therefore re-labelled as ‘To6’ and incorporated into the techno-overload sub-scale for the remainder of the analyses in this study. That TV1 loads onto the same factor as the techno-overload items supports Li and Wang’s (2021) suggestion that the techno-overload and techno-invasion sub-constructs overlap to the extent that these two sub-constructs should be merged in technostress research. The fourth item, Tc4, in the techno-complexity sub-scale failed to achieve the 0.40 threshold (Field, 2018), so was therefore omitted from further analyses. All other items achieved strong loadings onto the factors representing each of the techno-stress sub-scales, thereby confirming the validity of these sub-scale measures and associated items.

Technostress Inhibitor Scale

Table 4.5 summarises the factor loadings for the Technostress Inhibitor Scale sub-scale items.

Sub-scale	Item label	Factor	
		1	2
Literacy facilitation (2 items)	Tl1	.827	
	Tl2	.749	
Involvement facilitation (3 items)	Tf1	.585	
	Tf2	.756	
	Tf3	.544	
Technical support provision (2 items)	Tp1		-.949
	Tp2		-.976

Extraction Method: Principal Component Analysis
Rotation Method: Oblimin with Kaiser Normalization
KMO = 0.655
Bartlett Test for Sphericity: p <0.001

Table 4.5 Factor loadings for the Technostress Inhibitor Scale sub-scale items

The loadings in *Table 4.5* show that the items designed to measure the three sub-constructs of the Technostress Inhibitor Scale load only onto two factors. The items measuring literacy facilitation and involvement facilitation load onto the same factor, with items measuring technical support provision loading onto the second factor. The literacy facilitation and involvement facilitation items were therefore considered as a single technostress inhibitor, named 'techno-facilitation' for the remainder of the analyses for this study. The overall (cumulative) variance explained by these factors is 65%.

Literacy facilitation encompasses ways to encourage and support digital literacy development, while employee participation in decision-making regarding the selection and implementation of workplace technologies is the essence of involvement facilitation (Ragu-Nathan et al. 2008). However, it could be argued that a threshold level of digital literacy is required to be effective at making decisions required for effective involvement facilitation. Employees who have the opportunity to trial and use new technologies, becoming familiar with their features and applications, are better positioned to be effective decision-makers when involved in the recommendation and selection of technologies to be adopted by an organisation. This suggests that digital literacy facilitation and involvement facilitation are likely to be closely intertwined, potentially explaining why both of these technostress inhibitor constructs loaded onto the same factor (*Table 4.5*).

Work-related burnout

Table 4.6 summarises the factor loadings for the work-related burnout items.

Item label	**Factor**
	1
Bo1	.783
Bo2	.822
Bo3	.569
Bo4	.808
Bo5	.816
Bo6	.890

Extraction Method: Principal Component Analysis.
No rotation performed due to the extraction of only a single component.
KMO = 0.843
Bartlett Test for Sphericity: $p < 0.001$

Table 4.6 Factor loadings for work-related burnout items

All work-related burnout items loaded onto a single component, thereby indicating that they load onto the same factor. This supports these items as being valid as being considered as a single scale measure for work-related burnout for further analyses.

Work performance

Table 4.7 summarises the factor loadings for the work performance items.

Sub-scale	Item label	Factor 1
Productivity (3 items)	Pd1	.897
	Pd2	.907
Innovation (2 items)	In1	.851
	In2	.883
	Tf3	.865

Extraction Method: Principal Component Analysis

Rotation Method: with Kaiser Normalization

KMO = 0.784

Bartlett Test for Sphericity: p <0.001

Table 4.7 Factor loadings for the work performance items

Even though there are two sub-constructs – productivity and innovation – originally included in this analysis, *Table 4.7* shows how all factors load onto the same component. These items were therefore combined into a single work performance scale for the remaining analyses.

4.3.2 Cronbach's alpha – a measure of scale reliability

Table 4.8 shows the Cronbach alpha values calculated for the scales and subscales used in this study.

Scale	Sub-Scale	α-value
Technostress Creators	Techno-overload (6 items)	0.90
	Techno-invasion (3 items)	0.86
	Techno-complexity (4 items)	0.84
	Techno-insecurity (4 items)	0.77
	Techno-uncertainty (3 items)	0.64
	Technostress Creator Scale (20 items)	0.89
Work Performance	Work performance (5 items)	0.93
Work-Related Burnout	Work-related burnout (6 items)	0.87
Technostress Inhibitors	Techno-facilitation (5 items)	0.75
	Technical support provision (2 items)	0.96
	Technostress Inhibitor Scale (7 items)	0.79

Table 4.8 Cronbach alpha values (N=77)

The alpha value for the techno-uncertainty sub-scale of the Technostress Creator Scale was well below the desired 0.70 threshold value for internal scale consistency, with these items being excluded from further independent analyses. Exclusion of this measure as a technostress creator sub-construct is consistent with its omission in other studies (e.g., Tarafdar et al., 2015; Qi, 2019; Ioannou et al., 2022). As the overall Technostress Creator Scale, including these techno-uncertainty items, exceeds the 0.7 reliability threshold, these techno-uncertainty items were included in further analyses only as part of the overall Technostress Creator Scale. All other scale and sub-scale measures were deemed to demonstrate internal consistency, as their alpha values exceeded the 0.70 threshold, thereby supporting their application in further analyses in this study.

4.4 Common method bias

The Harman's single factor testing for the presence of common method bias yielded a single extracted factor, accounting only for 27% of the variance of the overall scale. This suggested that common method bias was not present in this study for the overall scale, as this value of 27% is below the commonly accepted 50%. This negated any concern that common method bias might unduly bias the results of this study (Fuller et al., 2016; Andrulli & Gerard, 2023).

4.5 Descriptive analyses

Tables 4.9 to *4.12* show the means, standard deviations, minimum and maximum values for constructs, sub-constructs and associated items. It is useful instead to consider the means of these measures with reference to the Likert response options that participants selected when completing the survey, where 1=s*trongly disagree;* 2=*somewhat disagree*; 3=*neither agree nor disagree;* 4=*somewhat agree*; 5=*strongly agree*. The values in *Tables 4.9* to *4.12* were rounded off to the nearest whole number to facilitate this. All mean scores are scored out of 5, to align with the scoring system used for the Likert scale adopted in this study.

The literature does not present standardised reference ranges for interpreting the mean responses of these constructs, subconstructs and individual items. Wang and Zhao's (2023) approach to interpreting the mean Technostress Creator Scale (Tarafdar et al., 2007; Tarafdar et al., 2011) values was adopted here to frame the interpretation of all the variable findings here. Wang and Zhao's (2023) approach to interpretation involves the labelling of mean Likert measures by labelling Likert scale (options 1 to 5) values up to a mean score of 3 as 'lower-middle' values, with mean Likert scale values of above 3 as 'upper-middle'. This was deemed the most relevant way of framing the interpretation of these mean findings for the following reasons: the educational context of the study, as it involved the measurement of technostress creators experienced by trainee student teachers; the contemporary nature of the study; the publication of the study in the British Journal of Educational Technology.

Analyses were undertaken for individual items, in addition to construct and sub-construct means, to contribute towards addressing *Research Question 2*, emphasising the identification of factors contributing to each of the technostress creators. This individual-item analysis was also done for the technostress inhibitor construct and subconstructs, as well as the work-related burnout and work performance constructs, as these analyses may be used to inform the discussion of the study hypothesis testing and associated findings.

Technostress creators

Measures	Mean		SD	Min	Max
	Statistic	SE			
(TSC) Technostress Creator Scale (20 items)	**2.84**	**0.08**	**0.67**	**1.35**	**4.15**
(TOL)	**3.24**	**0.12**	**1.03**	**1.00**	**5.00**
Techno-overload (6 items)					
I am forced by technology to work much faster	3.00	0.14	1.23	1.00	5.00
I am forced by technology to do more work than I can handle	2.92	0.14	1.25	1.00	5.00
I am forced by technology to work with very tight time schedules	2.99	0.15	1.32	1.00	5.00
I am forced to change my work habits to adapt to new technologies	3.81	0.13	0.15	1.00	5.00
I have a higher workload because of increased technology complexity	3.64	0.14	1.27	1.00	5.00
I spend less time with my family due to work-related technology	3.08	0.16	1.37	1.00	5.00
(TV) Techno-invasion (3 items)	**2.98**	**0.15**	**1.28**	**1.00**	**5.00**
I have to be in touch with my work even during my holidays due to work-related technology	3.13	0.17	1.52	1.00	5.00
I have to sacrifice my holiday and weekend time to keep current on new work-related technologies	2.68	0.16	1.36	1.00	5.00
I feel my personal life is being invaded by work-related technology	3.13	0.17	1.47	1.00	5.00

(TC) Techno-complexity (4 items)	**2.63**	**0.11**	**0.99**	**1.00**	**5.00**
I do not know enough about work-related technologies to handle my job satisfactorily	2.38	0.13	1.15	1.00	5.00
I need a long time to understand and use new work-related technologies	2.56	0.14	1.25	1.00	5.00
I do not find enough time to study and upgrade my work-related technology skills	3.36	0.14	1.23	1.00	5.00
I often find it too complex for me to understand and use new work-related technologies	2.23	0.13	1.16	1.00	5.00
(TIs) Techno-insecurity (4 items)	**1.77**	**0.08**	**0.77**	**1.00**	**5.00**
I feel constant threat to my job security due to new technologies	1.57	0.10	0.85	1.00	4.00
I have to constantly update my technological skills to avoid being replaced at work	1.94	0.12	1.04	1.00	5.00
I feel threatened by co-workers with newer technology skills	1.82	0.12	1.01	1.00	5.00
I feel there is less sharing of technology knowledge among co-workers for fear of being replaced	1.77	0.12	1.09	1.00	5.00

Table 4.9 Technostress Creator Scale descriptive statistics (N=77)

Table 4.9 shows that the overall Technostress Creator Scale mean scores aligns with the "*neither agree nor disagree*" Likert option. Similarly, the techno-overload, techno-invasion and techno-complexity mean scores also align with this option when the scores are rounded off to the nearest whole number. Despite this, the techno-overload score represents the highest mean sub-construct score, followed by the techno-invasion and techno-complexity scores. The mean score for techno-insecurity was the lowest of all the sub-constructs, aligning with the *"somewhat disagree"* Likert option.

Of the techno-overload items, both of the following statement mean scores align with the "*somewhat agree*" Likert option:

- *I am forced to change my work habits to adapt to new technologies.*
- *I have a higher workload because of increased technology complexity.*

The remaining techno-overload, all techno-invasion and the overall techno-complexity (incl. two statements) mean scores aligned with the "*neither agree nor disagree*" Likert option. However, the scores for two of the techno-complexity items aligned with the *"somewhat disagree"* option.:

- *I do not know enough about work-related technologies to handle my job satisfactorily.*
- *I often find it too complex for me to understand and use new work-related technologies.*

All techno-insecurity items aligned with the *"somewhat disagree"* option.

Technostress inhibitors

Measures	Mean		SD	Min	Max
	Statistic	SE			
(TSI) Technostress Inhibitor Scale (7 items)	**3.32**	**0.09**	**0.80**	**1.29**	**4.57**
(TF) Techno-facilitation (5 items)	**3.11**	**0.09**	**0.80**	**1.40**	**4.60**
My employer university encourages knowledge sharing to help deal with new technologies	3.39	0.13	1.11	1.00	5.00
My employer university provides training when new work-related technologies are introduced	3.65	0.15	1.31	1.00	5.00
Academic staff are encouraged to try out new technologies	3.70	0.12	1.03	1.00	5.00
Academic staff are rewarded for using new technologies	1.90	0.10	0.90	1.00	4.00
Academic staff are involved in work-related technology introduction, change and/or implementation.	2.92	0.14	1.27	1.00	5.00
(TSP) Technical support provision (2 items)	**3.45**	**0.15**	**1.32**	**1.00**	**5.00**
Our IT help desk is easily accessible	3.38	0.16	1.36	1.00	5.00
Our IT help desk is responsive to staff requests	3.53	0.15	1.34	1.00	5.00

Table 4.10 Technostress Inhibitor Scale descriptive statistics (N=77)

Table 4.10 shows that while all three mean scores for techno-inhibitor overall and sub-construct scales align with the *“neither agree nor disagree”* option, the technical support provision sub-construct mean was the highest mean score. When considering items at an individual level, two items of the techno-facilitation score align with the *“somewhat agree”* option:

- *My employer university provides training when new work-related technologies are introduced*
- *Academic staff are encouraged to try out new technologies*

While one of the technical support provision sub-construct scale items means also aligned with this Likert option:

- *Our IT help desk is responsive to staff requests*

One statement score aligned with the “*somewhat disagree*” option:

- *Academic staff are rewarded for using new technologies*

All other items aligned with the *“neither agree nor disagree”* option.

Work-related burnout

Measures	Mean		SD	Min	Max
	Statistic	SE			
(WBO) Work-related burnout (6 items)	**2.86**	**0.09**	**0.81**	**1.00**	**4.67**
I feel worn out at the end of the working day	3.56	0.11	0.98	1.00	5.00
I am exhausted in the morning at the thought of another day at work	2.58	0.13	1.12	1.00	5.00
I have enough energy for family and friends during leisure time*	2.53	0.12	1.02	1.00	5.00
My work is emotionally exhausting	2.97	0.12	1.06	1.00	5.00
My work frustrates me	2.82	0.11	0.96	1.00	5.00
I feel burnt out because of my work	2.64	0.13	1.10	1.00	5.00

**Item reverse-scored prior to analysis*

Table 4.11 Work-related burnout descriptive statistics (N=77)

Table 4.11 shows that while the overall work-related burnout mean, as well as the individual item means all aligned with the *"neither agree nor disagree"* Likert option, the exception to this was the following statement that aligned with the *"somewhat agree"* option:

- *I feel worn out at the end of the working day*

Work performance

Measures	Mean		SD	Min	Max
	Statistic	SE			
(WP) Work performance (5 items)	**3.38**	**0.13**	**1.10**	**1.20**	**5.00**
Technology helps to improve the quality of my work	3.55	0.13	1.13	1.00	5.00
Technology helps to improve my productivity associated with work	3.48	0.14	1.21	1.00	5.00
Technology allows me to accomplish more work than would otherwise be possible	3.49	0.14	1.23	1.00	5.00
Technology helps me create new ideas related to my work	3.13	0.16	1.38	1.00	5.00
Technology helps me to try out innovative ideas related to my work	3.23	0.15	1.32	1.00	5.00

**Item reverse-scored prior to analysis*

Table 4.12 Work performance descriptive statistics (N=77)

Table 4.12 shows that while the overall work performance mean, as well as the individual item means all aligned with the ‘*‘neither agree nor disagree”* Likert option, the exception to this was the following statement that aligned with the *“somewhat agree”* option:

- *Technology helps to improve the quality of my work*

4.6 Bivariate analyses

Bivariate analyses were undertaken to identify correlations between mean construct and sub-construct measures. The Pearson correlation analysis findings between study variables are summarised in the correlation matrix in *Table 4.13.* The main constructs and associated correlations are presented in bold, while the sub-constructs remain unbolded.

	1	2	3	4	5	6	7	8	9	10
1. TSC	**1**									
2. TOL	.849**	1								
3. TV	.710**	.579**	1							
4. TC	.709**	.445**	.202	1						
5. TIs	.572**	.218	.360**	.435**	1					
6. TSI	**-.340****	-.457**	-.150	-.145	-.131	1				
7. TF	-.222	-.300**	-.070	-.080	-.147	.901**	1			
8. TSP	-.384**	-.515**	-.212	-.186	-.056	.752**	.393**	1		
9. WBO	**.427****	.468**	.316**	.266*	.142	**-.364****	-.256*	-.384**	1	
10. WP	**-.460****	-.430**	-.094	-.507**	-.208	**.459****	.277*	.554**	**-.308****	**1**

*** Correlation is significant at the 0.01 level (2-tailed)*

**Correlation is significant at the 0.05 level (1-tailed)*

Bootstrap results are based on 1,000 bootstrap samples

Table 4.13 Correlation matrix (N=77)

Bivariate analyses revealed the existence of significant correlations between the main constructs as follows:

- A significant negative correlation was found between the overall measure of technostress creators and technostress inhibitors, $r(75) = -0.304$, $p = 0.01$. This confirms the existence of an inverse relationship between technostress creator and technostress inhibitors scores.
- A significant positive correlation was found between the overall measure of technostress creators and work-related burnout, $r(75) = 0.427$, $p = 0.01$. This confirms the existence of a direct relationship between technostress creator and work-related burnout scores.
- A significant negative correlation was found between the overall measure of technostress creators and work performance, $r(75) = -0.460$, $p = 0.01$. This confirms the existence of an inverse relationship between technostress creator and work performance scores.
- A significant negative correlation was found between the overall measure of technostress inhibitors and work-related burnout, $r(75) = -0.364$, $p = 0.01$. This confirms the existence of an inverse relationship between technostress inhibitors and work-related burnout scores.
- A significant positive correlation was found between the overall measures of technostress inhibitors and work performance, $r(75) = -0.459$, $p = 0.01$. This confirms the existence of a direct relationship between technostress inhibitors and work-related burnout scores.
- A significant negative correlation was found between the measures of work-related burnout and work performance, $r(75) = -0.308$, $p = 0.01$. This confirms the existence of an inverse relationship between work-related burnout and work performance scores.

4.7 Hypothesis testing

Hypothesis testing analyses were undertaken for both the main construct and sub-construct measures. This was to further support the identification of specific technostress creators that may influence individual and employee outcomes. This excluded the techno-uncertainty sub-construct, as it did not meet the validity criterion to be analysed independently.

Hypothesis 1 (H1):

Age-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers

Table 4.14 shows that the 46 – 55 years age group scored the highest overall technostress creator mean, with the lowest mean score for the 36 – 45 years age group. Techno-invasion was the highest technostress creators sub-construct mean measure for the 26 – 35 years age group, followed by the mean techno-overload score. However, techno-overload was the highest mean technostress creator sub-construct for both the 36 – 45 years and 46 to 55 years age groups, followed by the mean techno-invasion score. While techno-overload was the highest mean score for the 56 – 65 years age group, both techno-invasion and techno-complexity sub-construct scores followed this. The techno-insecurity sub-construct scores were the lowest for all age groups, aligning with the *"somewhat disagree"* Likert option.

Age	Overall technostress creators	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity
26 – 35 years (*N*=7)	2.74 ± 0.87	2.76 ± 0.95	3.38 ± 1.35	2.43 ± 1.09	2.11 ± 1.08
36 – 45 years (*N*=19)	2.67 ± 0.66	3.03 ± 1.01	2.63 ± 1.30	2.53 ± 1.07	1.63 ± 0.53
46 – 55 years (*N*=39)	2.93 ± 0.64	3.41 ± 0.97	3.11 ± 1.32	2.69 ± 0.96	1.83 ± 0.81
56 – 65 years (*N*=11)	2.81 ± 0.73	3.23 ± 1.27	2.76 ± 1.10	2.77 ± 1.03	1.68 ± 0.78
> 65 years (*N*=1)	3.10	4.00	4.00	2.50	1.00

Table 4.14 Summary of mean technostress creator scores by participant age group

A one-way ANOVA was performed to evaluate the relationship between age and technostress, as represented by the technostress creator main construct and subconstructs. One-way ANOVA findings (*Table 4.15*) are summarised here:

- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.715$, $p = 0.546$ for age-based comparisons of the overall technostress creator scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 1.133$, $p = 0.341$ for age-based comparisons of the techno-overload scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.931$, $p = 0.430$ for age-based comparisons of the techno-invasion scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.272$, $p = 0.845$ for age-based comparisons of the techno-complexity scores.

- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.757$, $p = 0.522$ for age-based comparisons of the techno-insecurity scores.

As there was only one participant in the > 65 years category, this age group was not included in the consideration of comparison of technostress creator means.

		Sum of Squares	df	Mean Square	F	Sig.
Overall technostress creators	Between Groups	0.993	3	.331	0.715	0.546
	Within Groups	33.321	72	.463		
	Total	34.314	75			
Techno-overload	Between Groups	3.589	3	1.196	1.133	0.341
	Within Groups	76.013	72	1.056		
	Total	79.602	75			
Techno-invasion	Between Groups	4.629	3	1.543	0.931	0.430
	Within Groups	119.277	72	1.657		
	Total	123.906	75			
Techno-complexity	Between Groups	0.832	3	.277	0.272	0.845
	Within Groups	73.348	72	1.019		
	Total	74.180	75			
Techno-insecurity	Between Groups	1.359	3	.453	0.757	0.522
	Within Groups	43.059	72	.598		
	Total	44.418	75			

Table 4.15 One-way ANOVA findings for comparison of technostress creator construct and sub-constructs by age

Conclusion: The findings do not support age-based differences in levels of technostress experienced by university lecturers. *Hypothesis 1* is therefore unsupported.

Hypothesis 2 (H2):

Gender-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.

Table 4.16 shows that the mean overall technostress creator and techno-invasion scores were similar for male and female participants, aligning with the *“neither agree nor disagree”* Likert option. In contrast, the mean techno-overload score for male participants was lower than that for female participants, with the mean male participant responses aligning with *“strongly disagree”*, while the mean female participant responses aligned with *“neither agree nor disagree”*. Similarly, the mean techno-complexity score for male participants was lower than that of the mean for female participants, aligning with *“somewhat disagree”* for male participants and *“neither agree nor disagree”* for female participants. The techno-insecurity sub-construct scores were the lowest for both females and males, aligning with the *“somewhat disagree”* Likert option.

Gender	Overall technostress creators	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity
Female (*N*=45)	2.84 ± 0.66	3.07 ± 0.98	3.00 ± 1.29	2.78 ± 0.92	1.87 ± 0.72
Male (*N*=30)	2.83 ± 0.71	3.46 ± 1.01	2.97 ± 1.26	2.35 ± 1.02	1.66 ± 0.84
Non-binary (*N*=1)	3.65	4.50	4.33	4.50	1.00
Prefer not to say (*N*=1)	2.45	3.17	1.00	2.75	1.75

Table 4.16 Summary of mean technostress creator scores by participant gender grouping

A one-way ANOVA was performed to evaluate the relationship between gender and technostress, as represented by the technostress creator main construct and subconstructs. One-way ANOVA findings (*Table 4.17*) are summarised here:

- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.586$, $p = 0.626$ for gender-based comparisons of the overall technostress creator scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 1.289$, $p = 0.285$ for gender-based comparisons of the techno-overload scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 1.183$, $p = 0.322$ for gender-based comparisons of the techno-invasion scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 2.359$, $p = 0.079$ for gender-based comparisons of the techno-complexity scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.684$, $p = 0.565$ for gender-based comparisons of the techno-insecurity scores.

		Sum of Squares	df	Mean Square	F	Sig.
Overall technostress creators	Between Groups	.818	3	.273	0.586	0.626
	Within Groups	33.496	72	.465		
	Total	34.314	75			
Techno-overload	Between Groups	4.057	3	1.352	1.289	0.285
	Within Groups	75.545	72	1.049		
	Total	79.602	75			
Techno-invasion	Between Groups	5.822	3	1.941	1.183	0.322
	Within Groups	118.084	72	1.640		
	Total	123.906	75			
Techno-complexity	Between Groups	6.638	3	2.213	2.359	0.079
	Within Groups	67.542	72	.938		
	Total	74.180	75			
Techno-insecurity	Between Groups	1.231	3	.410	0.684	0.565
	Within Groups	43.187	72	.600		
	Total	44.418	75			

Table 4.17 One-way ANOVA findings for comparison of technostress creator construct and sub-constructs by gender

Conclusion: The findings do not support gender-based differences in levels of technostress experienced by university lecturers. *Hypothesis 2* is therefore unsupported.

Hypothesis 3 (H3):

Education-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity (f) techno-uncertainty in university lecturers.

Table 4.18 summarises the means for the overall technostress creators construct measure, as well as the means for the sub-constructs when compared by categorisation of participants according to their level of education. The mean technostress creator and sub-construct scores all align with the "*neither agree nor disagree*" Likert option. Participants with Master's and PhD qualifications have similar mean levels of techno-overload, with these being higher than the mean techno-overload scores for participants with Honours degrees and post-graduate diplomas, with scores across all types of qualification aligning with the *"neither agree nor disagree"* Likert option. The highest mean techno-invasion score is for the participants with Honours degrees, aligning with the *"somewhat agree"* Likert option. The next highest techno-invasion score is for participants with Master's degrees, aligning with the *"neither agree nor disagree"* Likert option, as does the slightly lower techno-invasion mean score for participants with a PhD. Participants holding post-graduate diplomas have the lowest mean levels of techno-invasion, with the mean score aligning with the *"somewhat disagree"* option. The highest mean techno-complexity score is for participants holding Master's degrees, followed by those with PhDs and post-graduate diplomas, with the mean scores for all of these aligning with the *"neither agree nor disagree"* option. The lowest techno-complexity mean score is for participants holding Honours degrees, with a mean score aligning with the *"somewhat disagree"* Likert option. Participants with Honours degree had the highest mean techno-insecurity score, with the mean score aligning with the "somewhat disagree" option, as do the mean scores for holders of both post-graduate diplomas and Master's degrees. Those with PhDs have the lowest mean techno-insecurity scores, aligning with the *"strongly disagree"* Likert option.

Qualification Level	Overall technostress creators	Techno-overload	Techno-invasion	Techno-complexity	Techno-insecurity
Honours degree (*N*=2)	2.80 ± 0.85	2.83 ± 0.98	3.83 ± 1.65	2.00 ± 1.41	2.38 ± 0.18
Post-graduate diploma (*N*=3)	2.52 ± 0.62	2.83 ± 1.15	2.22 ± 1.17	2.67 ± 0.63	1.58 ± 0.38
Master's degree (*N*=38)	2.97 ± 0.65	3.30 ± 0.93	3.18 ± 1.25	2.82 ± 0.90	2.03 ± 0.88
PhD (*N*=34)	2.73 ± 0.69	3.23 ± 1.15	2.76 ± 1.30	2.46 ± 1.08	1.47 ± 0.54

Table 4.18 Summary of mean technostress creator scores by participant level of education

A one-way ANOVA was performed to evaluate the relationship between level of education and technostress, as represented by the technostress creator main construct and subconstructs. One-way ANOVA findings (*Table 4.19*) are summarised here:

- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.977$, $p = 0.409$ for education level-based comparisons of the overall technostress creator scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 0.267$, $p = 0.849$ for education level-based comparisons of the techno-overload scores.
- The ANOVA was not significant at the 0.05 level, $F(3,72) = 1.214$, $p = 0.311$ for education level-based comparisons of the techno-invasion scores.

- The ANOVA was not significant at the 0.05 level, $F(3,72) = 1.125$, $p = 0.345$ for education level-based comparisons of the techno-complexity scores.
- The ANOVA was significant at the 0.05 level, $F(3,72) = 4.382$, $p = 0.007$ for education level-based of the techno-insecurity scores. However, the results of the Tukey test did not support the statistical significance of this finding.

		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Overall technostress creators	Between Groups	1.342	3	.447	.977	.409
	Within Groups	32.972	72	.458		
	Total	34.314	75			
Techno-overload	Between Groups	.876	3	.292	.267	.849
	Within Groups	78.726	72	1.093		
	Total	79.602	75			
Techno-invasion	Between Groups	5.965	3	1.988	1.214	.311
	Within Groups	117.941	72	1.638		
	Total	123.906	75			
Techno-complexity	Between Groups	3.323	3	1.108	1.125	.345
	Within Groups	70.857	72	.984		
	Total	74.180	75			
Techno-insecurity	Between Groups	6.857	3	2.286	4.382	.007
	Within Groups	37.560	72	.522		
	Total	44.418	75			

Table 4.19 One-way ANOVA findings for comparison of technostress creator construct and sub-constructs by education level

Conclusion: The findings do not support an education level-based difference in levels of technostress creators, or its constituent subscales. *Hypothesis 3* is therefore unsupported.

Hypothesis 4 (H4):

The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty negatively predict work performance in university lecturers.

Overall Technostress: A statistically significant, negative relationship was shown between the overall technostress creator score and work performance (r = -0.46, p < 0.01) (*Table 4.13*) with bootstrapped linear regression of work performance onto the overall technostress creator score of (b = -0.76 [-1.029, -0.462], p < 0.001). The overall technostress creator score explains 21 percent of the variance in work performance.

Techno-Overload: A statistically significant, negative relationship was shown between the techno-overload score and work performance, (r = -0.43, p < 0.01) (*Table 4.13*), with bootstrapped linear regression of work performance onto techno-overload of (b = -0.46 [-0.669, -0.229], p < 0.001). Techno-overload explains 19 percent of the variance in work performance.

Techno-Complexity: A statistically significant, negative relationship was shown between the techno-complexity score and work performance, (r = -0.51, p < 0.01) (*Table 4.13*), with bootstrapped linear regression of work performance onto techno-overload of (b = -0.57 [-0.799, -0.320], p < 0.001). Techno-complexity explains 26 percent of the variance in work performance.

A significant correlation between two variables is a pre-requisite for linear regression analyses. As neither the techno-invasion nor techno-insecurity scores correlated statistically with work performance (*Table 4.13*), they did not meet the criteria for linear regression analysis.

Conclusion: Increased overall levels of overall technostress, levels of techno-overload and levels of techno-complexity are related to, and similarly predictive of, reduced work performance in a significant, negative, linear manner. These respectively account for 21%, 19% and 26% of the variance of work performance. This suggests that techno-complexity is responsible for the most variance of work performance, with the overall technostress measure, and techno-overload measures having a lesser, but similar, influence on work-performance. *Hypothesis 4* is therefore supported for the overall measure of technostress, techno-overload and techno-complexity, but not for measures of techno-invasion, techno-insecurity and techno-uncertainty.

Hypothesis 5 (H5):

The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty positively predict work-related burnout in university lecturers.

Technostress Creators: A statistically significant, positive relationship was shown between the overall technostress creator score and work-related burnout ($r = 0.43$, $p < 0.01$) (see *Table 4.13*) with bootstrapped linear regression of work-related burnout onto the overall technostress creator score of ($b = 0.52$ [0.306, 0.753], $p < 0.001$). The overall technostress creator score explains 18 percent of the variance in work-related burnout.

Techno-Overload: A statistically significant, positive relationship was shown between the techno-overload score and work-related burnout ($r = 0.47$, $p < 0.01$) (see *Table 4.13*) with bootstrapped linear regression of work-related burnout onto the techno-overload score of ($b = 0.37$ [0.208, 0.547], $p < 0.001$). The techno-overload score explains 22 percent of the variance in work-related burnout.

Techno-Invasion: A statistically significant, positive relationship was shown between the techno-invasion score and work-related burnout ($r = 0.32$, $p < 0.01$) (see *Table 4.13*) with bootstrapped linear regression of work-related burnout onto the techno-invasion score of ($b = 0.20$ [0.061, 0.350], $p < 0.001$). The techno-overload score explains 10 percent of the variance in work-related burnout.

Techno-Complexity: A statistically significant, positive relationship was shown between the techno-complexity score and work-related burnout ($r = 0.27$, $p < 0.05$) (see *Table 4.13*) with bootstrapped linear regression of work-related burnout onto the techno-complexity score of ($b = 0.22$ [0.013, 0.404], $p < 0.001$). The techno-complexity score explains 7 percent of the variance in work-related burnout.

A significant correlation between two variables is a pre-requisite for linear regression analyses. As there was no significant correlation between techno-insecurity and work-related burnout, (*Table 4.13*) this sub-construct did not meet the criteria for linear regression analysis.

<u>Conclusion</u>: Increased overall levels of overall technostress, levels of techno-overload, techno-invasion and techno-complexity are related to, and similarly predictive of, increased work-related burnout in a significant, positive, linear manner. These respectively account for 18%, 22%, 10% and 7% of the variance of work-related burnout. This suggests that techno-overload is responsible for the most variance of work-related burnout, followed by the overall technostress creator measure, techno-invasion and techno-complexity. *Hypothesis 5* is therefore supported for the overall measure of technostress creators, techno-overload, techno-invasion and techno-complexity, but not for measures of techno-insecurity and techno-uncertainty.

Hypothesis 6 (H6):

Work-related burnout positively predicts work performance in university lecturers

A statistically significant, negative relationship was shown between work-related burnout and work performance, ($r = -0.31$, $p < 0.01$) (see *Table 4.13)* with bootstrapped linear regression of work performance onto work-related burnout of ($b = -0.42$ [-0.690, -0.101], $p < 0.001$). Work-related burnout explains 10 percent of the variance in work performance.

Conclusion: Increased levels of work-related burnout are predictive of reduced levels of work performance in a significant, negative, linear relationship. *Hypothesis 6* is therefore supported.

Hypothesis 7 (H7):

Work-related burnout partially mediates the relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.

Technostress Creator Scale: Figure 4.1 shows that there was only a direct, significant effect of technostress creators on work performance with work-related burnout in the model. There was no statistically significant, indirect effect of technostress creators on work performance through work-related burnout. No mediation effect of work-related burnout was demonstrated.

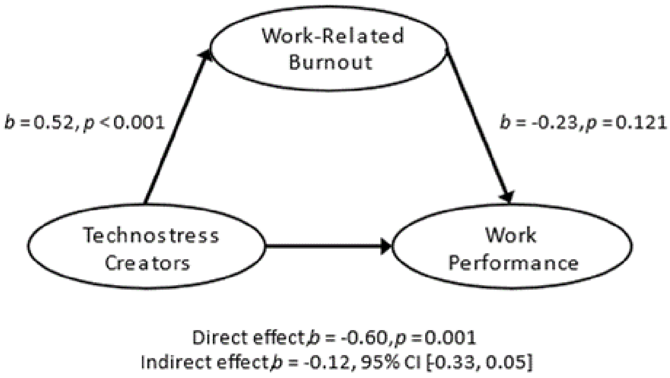

Figure 4.1 Simple mediation results: Technostress creators-work-related burnout-work performance relationship

Techno-overload: Figure 4.2 shows that there was only a direct, significant effect of techno-overload on work performance with work-related burnout in the model. There was no statistically significant, indirect effect of techno-overload on work performance through work-related burnout. No mediation effect of work-related burnout was demonstrated.

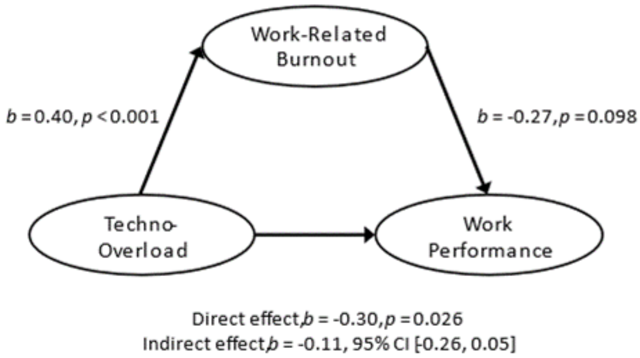

Figure 4.2 Simple mediation results: Techno-overload-work-related burnout-work performance relationship

Techno-invasion: Figure 4.3 shows that there is no direct, significant effect of techno-invasion on work performance, with work-related burnout in the model.

There is however an indirect, significant effect of techno-invasion on work performance with work-related burnout in the model. A mediation effect of work-related burnout was demonstrated.

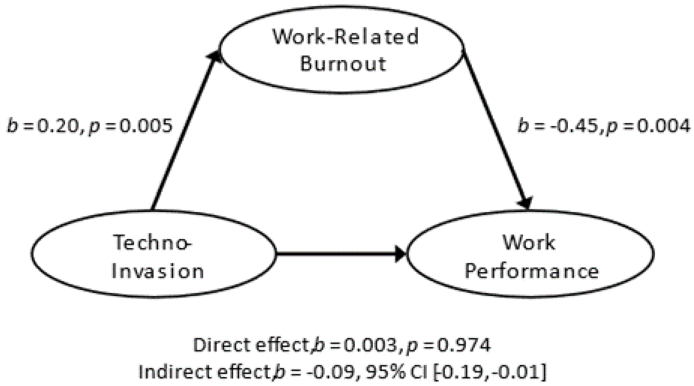

Figure 4.3 Simple mediation results: Techno-invasion-work-related burnout-work performance relationship

Techno-complexity: Figure 4.4 shows that there was only a direct, significant effect of techno-complexity on work performance with work-related burnout in the model. There was no statistically significant, indirect effect of techno-complexity on work performance through work-related burnout. No mediation effect of work-related burnout was demonstrated.

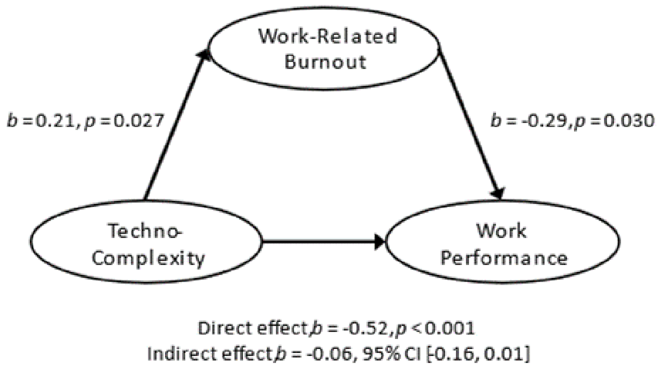

Figure 4.4 Simple mediation results: Techno-complexity-work-related burnout-work performance relationship

Techno-Insecurity: Figure 4.5 shows that there was only a direct, significant effect of techno-insecurity on work performance with work-related burnout in the model. There was no statistically significant, indirect effect of techno-insecurity on work performance through work-related burnout. No mediation effect of work-related burnout was demonstrated.

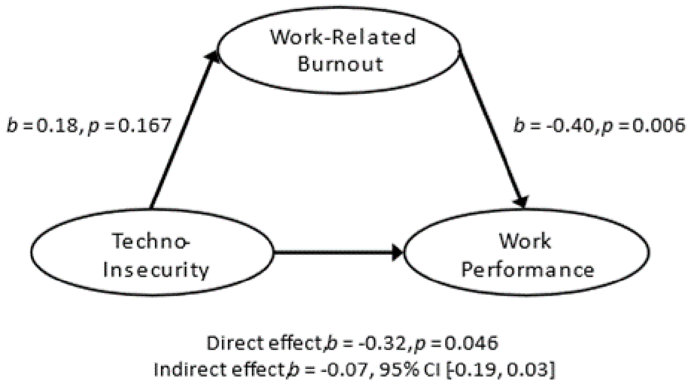

Figure 4.5 Simple mediation results: Techno-insecurity-work-related burnout-work performance relationship

<u>Conclusion</u>: Techno-invasion is the only technostress measure that has an indirect effect on work performance through work-related burnout. This shows that work-related burnout partially explains the inverse relationship between

techno-invasion and work performance. Overall technostress creators, techno-overload, techno-complexity and techno-insecurity have no indirect effect on work performance through work-related burnout as a mediator in these relationships. This shows that work-related burnout does not influence the relationship between these technostress measures and work-related burnout. *Hypothesis 8* is therefore supported for the techno-invasion measure only.

Hypothesis 8 (H8): The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.

Tables 4.20 and *4.21* summarise the findings of the analyses undertaken using the Hayes PROCESS Model 1. Only the overall technostress creator measure, as well as sub-scales of techno-overload and techno-complexity were included in the testing of this hypothesis. The techno-invasion and techno-uncertainty measures were excluded from this analysis, due to the lack of a significant predictive relationship between these measures and work performance (*Hypothesis 4*).

Interaction	*b*	*SE B*	*t*	*p*
Technostress Creators X Technostress Inhibitors	-0.16 [-0.61, 0.28]	0.222	-0.731	0.467
Techno-Overload X Technostress Inhibitors	0.26 [-0.07, 0.58]	0.162	1.580	0.117
Techno-Complexity X Technostress Inhibitors*	-0.23 [-0.50, -0.02]	0.121	-2.218	0.033
Technostress Creators X Technostress Facilitation	-0.17 [-0.61, 0.27]	0.219	-0.780	0.439
Techno-Overload X Techno-Facilitation	0.23 [-0.07, 0.55]	0.159	1.452	0.151
Techno-Complexity X Techno-Facilitation⁺	-0.31 [-0.54, 0.07]	0.119	-2.567	0.012
Technostress Creators X Technical Support Provision	-0.03 [-0.31, 0.25]	0.142	-0.210	0.836
Techno-Overload X Technical Support Provision	-0.04 [-0.77, 0.69]	0.367	0.110	0.916
Techno-Complexity X Technical Support Provision	-0.02 [-0.18, 0.13]	0.077	-0.300	0.762

* R^2 = 49%

⁺ R^2 = 44%

Table 4.20 Hypothesis 8 moderation interaction effects

While no statistically significant moderation effects were demonstrated for most of the interactions tested, there were two interactions that met the criteria for statistical significance.

Techno-complexity X technostress inhibitors

The interaction between techno-complexity and technostress inhibitors is statistically significant, demonstrating that the overall technostress inhibitor measure moderates the negative relationship between techno-complexity and work performance. Simple slopes analysis (Field, 2018) of the data, as shown in *Figure 4.6*, demonstrates that when the level of technostress inhibitors is low, there is a negative relationship between techno-complexity and work performance. At the mean (medium) of technostress inhibitors, there is a stronger negative relationship between techno-complexity and work performance. This relationship strengthens at higher levels of technostress inhibitors.

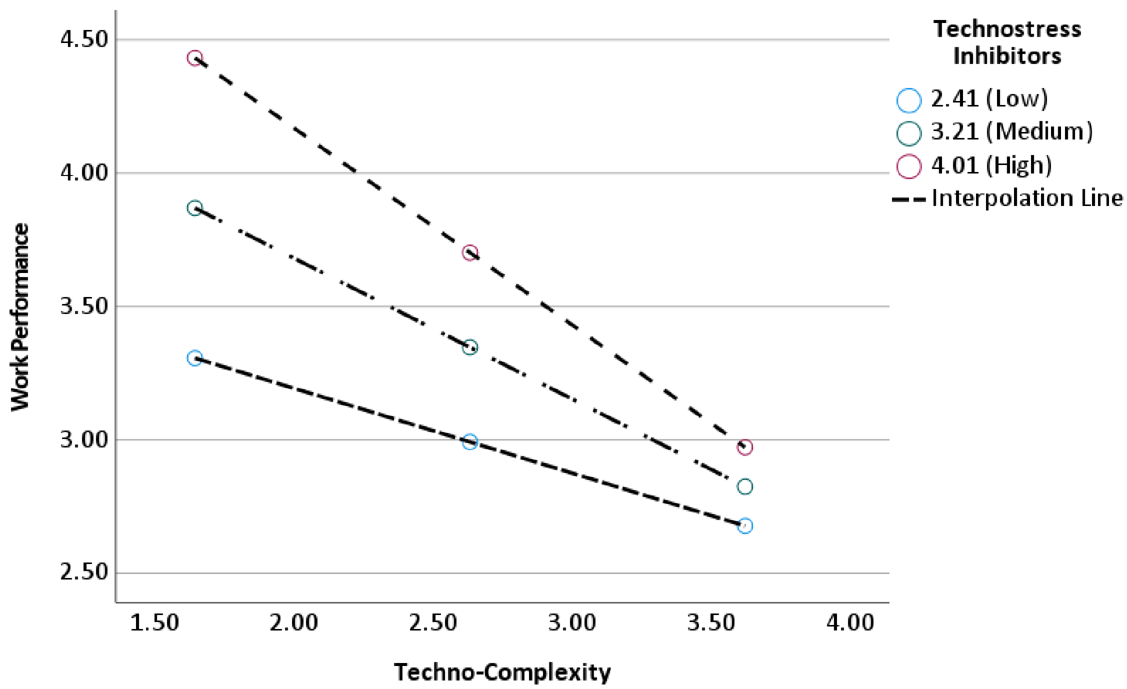

Figure 4.6 Regression of work performance on techno-complexity at three levels of technostress inhibitors (unstandardised variables)

Techno-complexity X techno-facilitation

The interaction between techno-complexity and techno-facilitation is statistically significant, demonstrating that the overall techno-facilitation measure moderates the negative relationship between techno-complexity and work performance. Simple slopes analysis (Field, 2018) of the data, as shown in *Figure 4.7*, demonstrates that when the level of techno-facilitation is low, there is a negative relationship between techno-complexity and work performance. At the mean (medium) of techno-facilitation, this negative relationship between techno-complexity and work performance strengthens, with this negative relationship becoming stronger at higher levels of techno-facilitation.

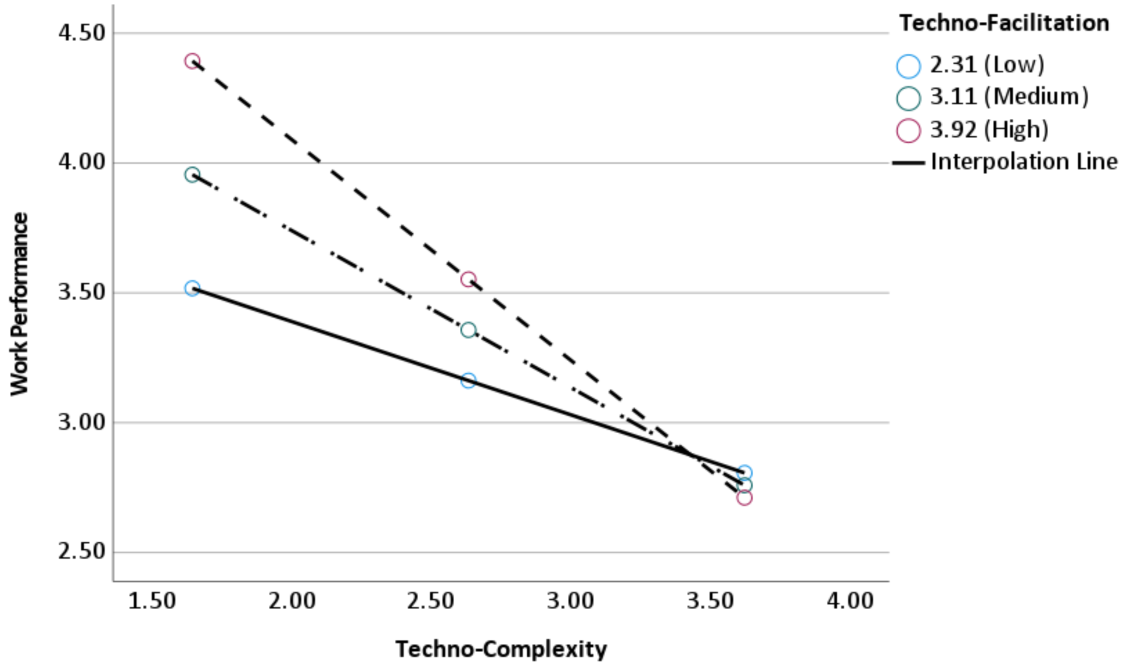

Figure 4.7 Regression of work performance on techno-complexity at three levels of techno-facilitation (unstandardised variables)

Conclusion: Both the overall technostress inhibitor measure and techno-facilitation further exacerbates the reduction in work performance caused by techno-complexity, thereby increasing the negative effects of techno-complexity on work performance. *Hypothesis 8* is therefore partially supported.

Hypothesis 9 (H9):

The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work-related burnout in university lecturers.

Table 4.21 summarises the findings of the interaction analyses undertaken. Only the overall technostress creator measure, as well as sub-scales of techno-overload, techno-invasion and techno-complexity were included in the testing of this hypothesis.

Interaction	***b***	***SE B***	***t***	***p***
Technostress Creators X Technostress Inhibitors	0.09 [-0.26, 0.43]	0.173	0.508	0.613
Techno-Overload X Technostress Inhibitors	-0.19 [-0.43, 0.04]	0.118	-1.627	0.108
Techno-Invasion X Technostress Inhibitors*	0.20 [0.03, 0.36]	0.085	2.300	0.024
Techno-Complexity X Technostress Inhibitors	0.07 [-0.15, 2.88]	0.109	0.656	0.514
Technostress Creators X Technostress Facilitation	0.17 [-0.17, 0.50]	0.168	1.009	0.317
Techno-Overload X Techno-Facilitation	-0.07 [-0.30, 0.16]	0.115	-0.606	0.546

Techno-Invasion X Techno-Facilitation	0.16 [-0.02, 0.33]	0.088	1.818	0.073
Techno-Complexity X Techno-Facilitation	0.09 [-0.12, 0.30]	0.107	0.825	0.412
Technostress Creators X Technical Support Provision	-0.09 [-0.32, 0.15]	0.116	-0.738	0.463
Techno-Overload X Technical Support Provision+	-0.20 [-0.35, -0.06]	0.071	-2.856	0.006
Techno-Invasion X Technical Support Provision	0.07 [-0.04, 0.17]	0.053	1.242	0.219
Techno-Complexity X Technical Support Provision	0.02 [-0.13, 0.16]	0.073	-0.223	0.824

*R^2=32%

+*R^2=22%*

Table 4.21 Hypothesis 9 moderation interaction effects

While no statistically significant moderation effects were demonstrated for most of the interactions tested, there were two interactions that met the criteria for statistical significance. The interaction between techno-invasion and technostress inhibitors is statistically significant, demonstrating that the overall technostress inhibitor measure moderates the negative relationship between techno-invasion and work-related burnout.

Techno-invasion X technostress inhibitors

The interaction between techno-invasion and technostress inhibitors is statistically significant, demonstrating that the overall technostress inhibitors measure moderates the positive relationship between techno-invasion and work-related burnout. Simple slopes analysis (Field, 2018) of the data, as shown in

Figure 4.8, demonstrates that when the level of technostress inhibitors is low, there is only a very marginal positive relationship between techno-invasion and work-related burnout. This relationship is stronger at the mean (medium) level of technostress inhibitors, strengthening further at higher levels of technostress inhibitors.

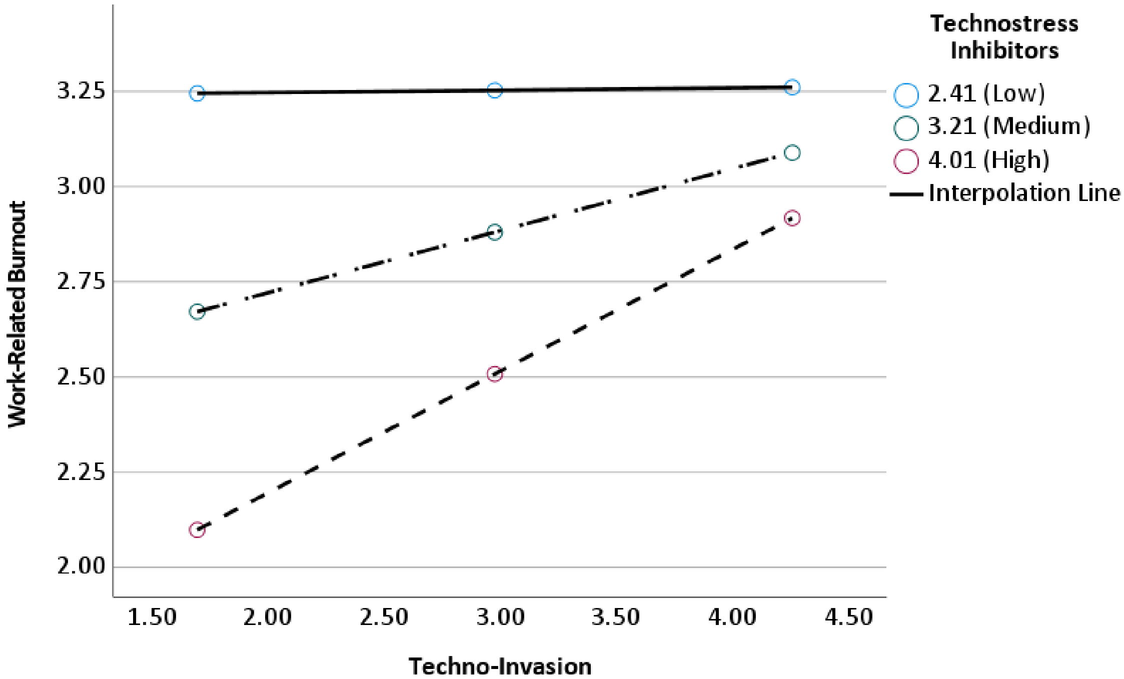

Figure 4.8 Regression of work-related burnout on techno-invasion at three levels of technostress inhibitors (unstandardised variables)

Techno-overload X technical support provision

The interaction between techno-overload and technical support provision is statistically significant, demonstrating that the overall technical support provision measure moderates the negative relationship between techno-overload and work-related burnout. Simple slopes analysis (Field, 2018) of the data, as shown in *Figure 4.9*, demonstrates that when the level of technostress support provision is low, there is a strong positive relationship between techno-overload and work-related burnout. This relationship between techno-invasion and work-related burnout weakens at the mean (medium) level of technical support provision, becoming even weaker at higher levels of technostress inhibitors.

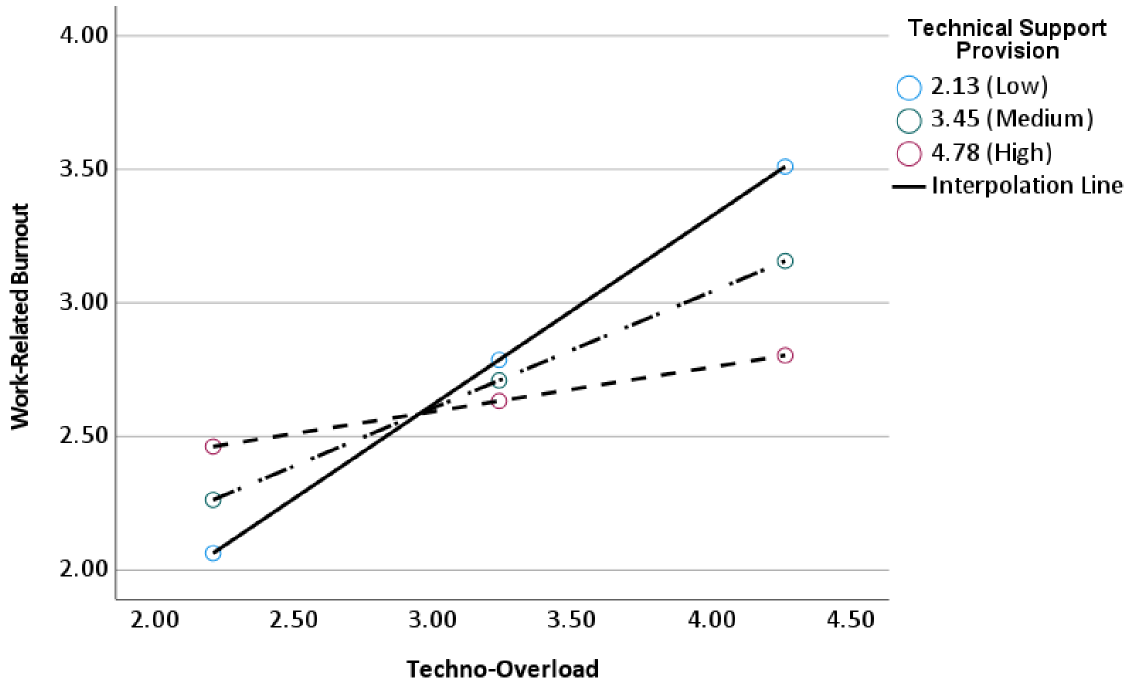

Figure 4.9 Regression of work-related burnout on techno-overload at three levels of technical support provision (unstandardised variables)

<u>Conclusion</u>:

Overall technostress inhibitors strengthens the positive relationship between techno-invasion and work-related burnout. Technical support provision weakens the positive relationship between techno-overload and work-related burnout. *Hypothesis 9* is therefore partially supported.

Hypothesis 10 (H10):

The (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty is related to work performance through work-related burnout, with both the direct and mediated effects influenced by the (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision in university lecturers.

The final hypothesis was a test of the moderated mediation model (*Figure 4.10*), representing a composite of the models tested in *Hypotheses 4* to *9*. The technostress creator score represents the independent (predictor) variable, with work-related burnout at the mediator (M) variable and work performance as the independent (outcome) variable. Technostress inhibitors is the moderating (W) variable, moderating the technostress creator – work performance and technostress creator – work-related burnout relationships.

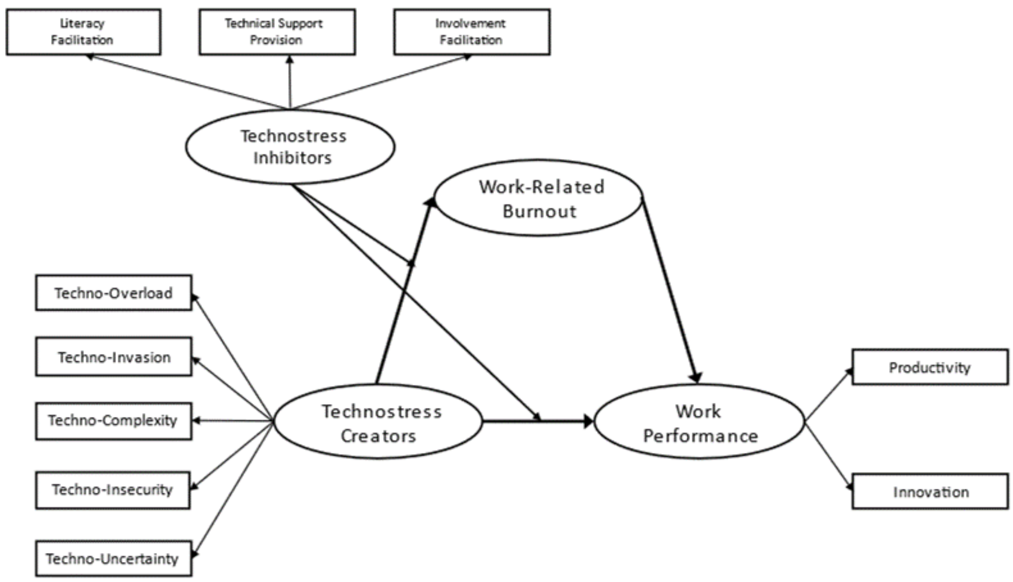

Figure 4.10 Moderated mediation model

The moderated mediation model was not supported for any combination of main scale and sub-scale measures.

Conclusion: The mediated moderation relationships do not all co-exist for the variables in this study.

Summary of hypothesis testing findings

Table 4.22 summarises the findings of the afore-mentioned hypotheses testing.

Hypothesis	Hypothesis description	Hypothesis testing outcomes
H1	Age-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.	Unsupported
H2	Gender-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty in university lecturers.	Unsupported
H3	Education-based differences exist in the experiences of (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity (f) techno-uncertainty in university lecturers.	Unsupported
H4	The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty negatively predict work performance in university lecturers	Supported for: • Overall level of technostress → work performance • Techno-overload → work performance • Techno-complexity → work performance

H5	The (a) overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty positively predict work-related burnout in university lecturers.	Supported for: • Overall level of technostress → work-related burnout • Techno-overload → work-related burnout • Techno-invasion → work-related burnout • Techno-complexity → work-related burnout
H6	Work-related burnout positively predicts work performance in university lecturers.	Supported
H7	Work-related burnout partially mediates the relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.	Supported for: • Techno-invasion → work-related burnout → work performance
H8	The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work performance in university lecturers.	Supported for: • Techno-complexity X overall technostress inhibitors → work performance • Techno-complexity X techno-facilitation → work performance

H9	The (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision moderate the negative relationship between (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty and work-related burnout in university lecturers.	Supported for: • Techno-invasion X overall technostress inhibitors → work-related burnout • Techno-overload X technical support provision → work-related burnout
H10	The (a) the overall level of technostress, (b) techno-overload, (c) techno-invasion, (d) techno-complexity, (e) techno-insecurity, (f) techno-uncertainty is related to work performance through work-related burnout, with both the direct and mediated effects influenced by the (a) overall level of technostress inhibitors (b) techno-facilitation, (c) technical support provision in university lecturers.	Unsupported

Table 4.22 Summary of hypothesis testing findings

4.8 Analysis of participant narrative contributions

The questionnaire distributed to participants for the purposes of data collection for this survey concluded with the following invitations for further contributions from respondents regarding their perceptions of the use of digital technologies in educational workplaces:

- *“Please describe what you perceive as the benefits (for the lecturer) of using digital technologies in a higher education workplace.”*
- *“Please describe what you perceive as the disadvantages (for the lecturer) of using digital technologies in a higher education workplace.”*
- *“Please share any other thoughts that you have concerning the use of digital technologies in your workplace and the impact that they may have on you and how you approach your work.”*

These statements were purposefully phrased in an open-ended manner, so as not to bias the participants’ responses. The participant responses did not strictly align with each of the statements above. It was therefore decided to pool all responses together into a single data pool prior to undertaking thematic analysis. A hybrid deductive-inductive thematic analysis (Braun & Clarke, 2006) was applied to this data. Sections 4.8.1 to 4.8.4 below represent themes associated with deductive analyses, while Section 4.8.5 presents themes arising out of inductive analyses.

4.8.1 Technostress Creators

Participant responses most strongly aligned to the theme of techno-overload, followed by techno-invasion, techno-uncertainty, techno-complexity and – lastly – techno-insecurity.

Techno-overload

Techno-overload refers to a worker feeling inundated with information and work expectations, demanding a faster pace of work and longer working hours, attempting to meet the expectations of the ICT-associated workload (Tarafdar et al., 2007; Tarafdar et al., 2010). The increased workload associated with the use of digital technologies in academic workplaces is evidenced by the following participant narrative:

> *“Some technologies increase your workload instead of simplifying it.”*

The thematic map in *Figure 4.11* summarises the main sub-themes associated with the techno-overload theme. These are described in *Table 4.23*, using participant narratives to support these descriptions.

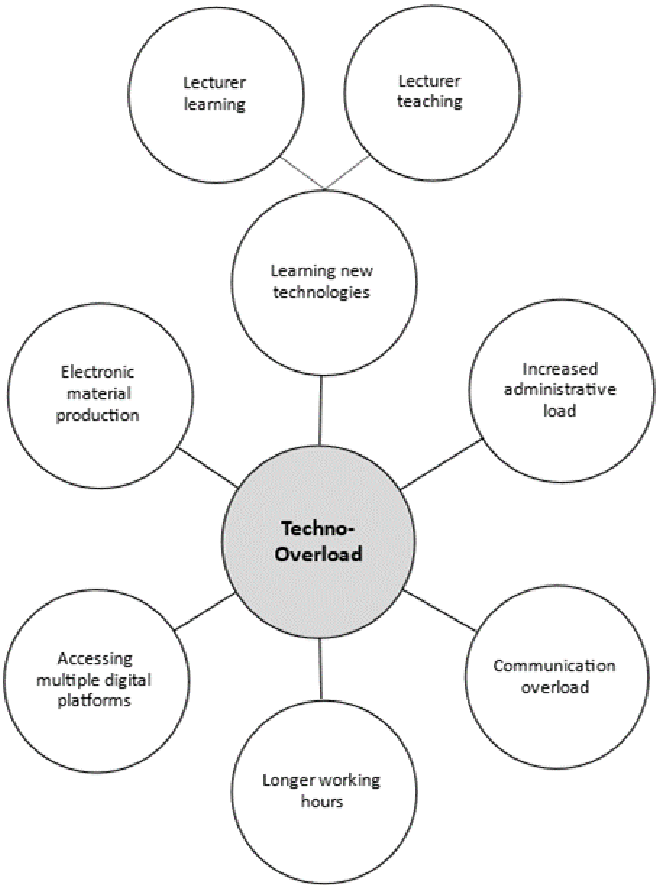

Figure 4.11 Thematic map of techno-overload and sub-themes

Sub-theme	Description	Supporting narratives
Learning new technologies	***Lecturer learning*** Lecturers are expected to become proficient in the use of new technologies, in addition to their other work responsibilities, thereby adding to their overall workload. While some participant narratives recognise the value of educational technologies, they also highlight the lack of time to select and engage with these technologies to realise their full benefits.	***Lecturer learning*** *"While our [name of university unit supporting teaching, learning and assessment] office is excellent, you have to access it in your own time (which I have done but as a new lecturer my time is limited)."* *"While some digital technologies like [name of LMS] are very well supported, there does not appear to be support on our campus for important management tools like Outlook, Adobe Acrobat Pro and those mentioned above. These technologies have the capability to make our working life easier and more efficient if leveraged properly. Unfortunately with little training, they tend to add to our workload and do become a point of stress."*
	Lecturer teaching Lecturers are at times expected to teach students how to use educational technologies, increasing their overall workload while also placing additional demands on their time.	***Lecturer teaching*** *"Some students may not see fit to learn how to use digital technologies and this induction may fall to the lecturer."*

Increased administrative load	Increased use of digital technologies in higher education is also associated with changed work practices, including increased expectations that lecturers assume additional administrative functions. Participant narratives suggest that this leads to frustration and poor lecturing staff morale, compounded by the poor quality of the administrative ICT systems they are expected to use.	*"While very useful for academic related research, it is most unfortunate that administrative positions have been decimated throughout different schools within my employer university which leads to unfair distribution of administrative tasks as some academic staff refuse to engage which in turn leads to poor morale among academic staff. This system is broken, unsustainable and many academic staff are very unhappy."* *"Much more administrative work expected on top of full timetable. Technology has caused the demise of many administrative roles and has pushed this responsibility onto academic staff beyond their contractual obligations"* *"Automate manual processes but the result is the University puts responsibility on Faculty rather than hire an administrator to do routine admin tasks."* *"Also the systems that are being selected for admin tasks are awful - down to poor management."*
Production of electronic educational materials	Participant narratives suggest that both students and management have expectations that academic staff make all lecture material available to students to electronic formats. This extends to regular updating of these resources. These expectations add to the overall lecturer workload.	"*It generally means more work, as students and managers expect more. For example, students expect face-to-face interaction but also pre-recorded material."* *"…the expectation on lecturers now to make every resource accessible through LMS is increasing, and this in itself is time consuming."*

Communication overload	Lecturers are expected to engage in multiple technologies to communicate with management, colleagues and students, leading to communication overload. This leads to additional time pressure and overwhelm experienced by lecturers.	*"There are so many different means of communication within the university all of this needs to be rationalised, it is overwhelming sometimes."*
Accessing multiple digital platforms	Insufficient integration of technological systems increases the overall workload for the lecturer, meaning they have to access multiple ICT systems, with multiple log-ins to undertake their work.	*"For example to access my work email at work I have to use three different usernames, sign in up to four times and use an authenticator app. It takes ages even when I remember it all."* *"There is too much repetition of certain data, e.g. assessment results have to be entered into two separate apps with an additional application process of exam correction fees required even though all the relevant information is already recorded in the various apps."*
Longer working hours	Many participant narratives suggest that lecturers are working longer hours due to their overall workload. This extension of working hours is facilitated by remote accessibility of most modern-day educational technologies. Having to work longer hours also relates directly to ***Theme 2: Techno-Invasion***, which is described next.	*"Tendency to work longer hours with Work From Home enabled."* *"I am working longer than I should each day."*

Table 4.23 Narrative excerpts for techno-overload and sub-themes

Techno-invasion

Techno-invasion is closely related to techno-overload. This encompasses the expectation that the worker is ”always-on”, being expected to be connected to, and contactable by, those in the workplace at any time or location (Tarafdar et al., 2007; Tarafdar et al., 2010). The thematic map in *Figure 4.12* summarises the main sub-themes associated with the techno-invasion theme. These are described in *Table 4.24*, using participant narratives to support these descriptions.

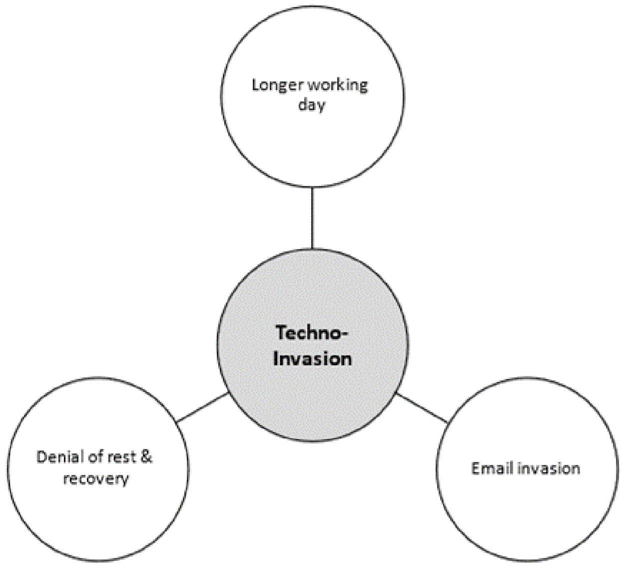

Figure 4.12 Thematic map of techno-invasion and sub-themes

Sub-theme	Description	Supporting narrative(s)
Longer working day	Remote access to educational technologies is often associated with the expectation that lecturers are “always-on” and available to engage in electronic communications outside of normal working hours. The longer working day, as reported in ***Theme 1: Techno-Overload***, is also a consideration regarding the way in which work invades non-work time.	*“Allows me to work at night which allows me to keep up with the heavy workload.”* *“I know we have the right to disconnect outside of work hours but with the volume of work, coupled with the ability to engage with work outside core hours, it is almost impossible to do so effectively and with consistency.”*
Email invasion	A number of participant narratives suggested that they felt that emails invaded their non-work time, associated with the expectation from students and managers that lecturers response immediately to such communications.	*“The constant issue of being "always-on". People assume that because they can email you at any time, that you should respond to them at any time.”* *“Students emailing with queries outside of business hours, including at weekends, and expecting an immediate response. Perception by some students that lecturers operate a "call centre"-type support service.”* *“Constant intrusion into personal time by messaging from students in particular but also, in some cases, out of hours messaging from management”*

Denial of rest and recovery	The blurring work-life boundaries facilitated by digital technologies associated with higher education workplaces also denies the lecturer time to detach from work, to rest and recover.	*"Work-life boundaries blur, checking/responding to emails impacts sleep, expectations to be constantly contactable."* *"Very limited opportunity for annual leave which is undisturbed."*

Table 4.24 Narrative excerpts for techno-invasion and sub-themes

Techno-complexity

Techno-complexity leads to ICT-related stress when a worker feels overwhelmed by the demands of workplace technologies and the expectation that they will attain and maintain ICT-related proficiency and associated efficiencies (Tarafdar et al., 2007; Tarafdar et al., 2010).

The thematic map in *Figure 4.13* summarises the main sub-themes associated with the techno-complexity theme. These are described in *Table 4.25*, using participant narratives to support these descriptions.

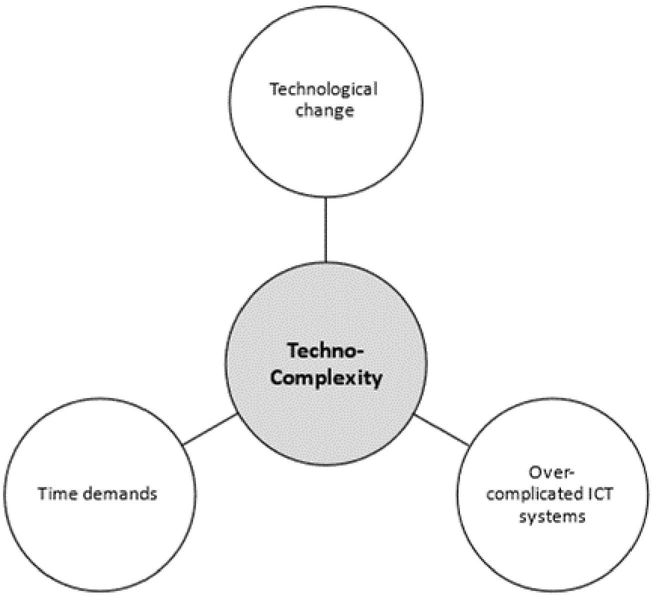

Figure 4.13 Thematic map of techno-complexity and sub-themes

Sub-theme	Description	Supporting narrative(s)
Technological change	Some participant narratives suggest that regular changes in educational technologies are challenging to keep up with. This creates an additional burden on the lecturer, as it increases their overall workload. One respondent also expressed that it had a negative effect on university lecturer well-being, in that such ongoing technological change leads to burnout.	*"Constant change can lead to frustration and feeling burnt out."* *"The technology frequently changes and it is often difficult to keep up."* *"Technologies change, university change licenses which can mean re-creating a lot of content for students"*
Over-complicated ICT systems	Some participant narratives suggested that technological systems that were effective at a lower level of technological development have become more ineffective due to their increased complexity.	*"Simple tools such as printers and photocopiers need to be less 'smart' and just do as they are told. I am quicker on 30-year-old photocopiers than the new ones, where half the time you just give up."* *"They do not make the job easier often they complicate tasks that were already being performed effectively."*

Time demands	A number of participants expressed concern about the time that it takes to attain and maintain competency in using ICT systems. That the time needed for maintaining these ICT skills is in addition to their other work responsibilities adds to their overall workload.	*"Time consuming to develop skills to be competent in new technology…"* *"Takes too much of my time - learning new systems - it is moving too fast."* *"…finding the time to learn the tech can be tricky on top of all of the other duties that come with teaching…"*

Table 4.25 Narrative excerpts for techno-complexity and sub-themes

Techno-insecurity

Techno-insecurity describes the fear of being replaced by other workers with greater ICT proficiencies. This may also extend to a fear of being replaced by the ICT systems themselves (Tarafdar et al., 2007).

4.8.2 Technostress Inhibitors

Participant responses related to technostress inhibitors of literacy facilitation, involvement facilitation and technical support provision are described and summarised here.

Literacy facilitation

This encompasses both formal and informal organisational training and learning initiatives encouraging the sharing of ICT-related knowledge within the workplace (Ragu-Nathan et al., 2008). The thematic map in *Figure 4.14* summarises the main sub-themes associated with the literacy facilitation theme. These are described in *Table 4.26*, using participant narratives to support these descriptions. These also include suggestions from participants as to how digital literacy of lecturers can be enhanced.

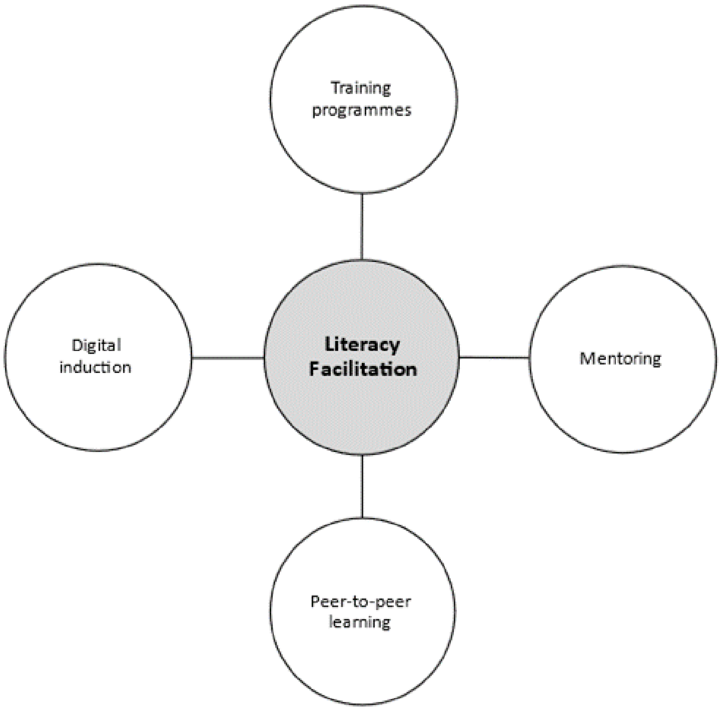

Figure 4.14 Thematic map of literacy facilitation and sub-themes

Sub-theme	Description	Supporting narrative(s)
Formal training programmes	Participant narratives highlighted the need for training in the use of digital educational technologies, and that lecturers should not be expected to self-train themselves on these technologies. Participant narratives also suggest that training on educational pedagogies is also needed to be able to use these technologies effectively.	*“We just need more time and training on how to get the best use from new technologies…”* *“Time consuming to develop skills to be competent in new technology as it is mainly left up to the individual to upskill.”* *“Training required not just on the technology, but also on the teaching and learning methods best suited for use of these new technologies.”*
Digital induction	Some participants suggested that a digital induction should be included in the staff induction programme at the time of commencement of employment.	*“There isn't always a clear introduction to digital technologies for lecturers…”* *“A comprehensive digital induction, before beginning working in academia, would be beneficial i.e. a week where the new employee is brought through the systems in a comprehensive manner with other new colleagues.”*

Peer-to-peer learning	The importance of peer-to-peer learning in improving knowledge and skills related to workplace ICTs was emphasised by some participants. However, concern was expressed that this would potentially add to their peer's workload.	*"I have good colleagues and we learn together."* *"Although my work colleagues were most generous in their offers of help and actually proactively sat down with me to show me around various software systems, it is very hard, as a person who has been very autonomous in their career to date, to be going back to people with all the necessary questions and disturbing them from their own very busy work schedules."*
Mentoring	Two participants suggested that peer mentoring would facilitate learning about technologies in the academic workplace.	*"…we need mentors to show how we could use available tech in class etc…"* *"Getting back to work after a career break was very tricky, a technology mentor would have been an excellent help, people are so busy that you sometimes don't want to bother them by asking for help in a more casual setting."*

Table 4.26 Narrative excerpts for literacy facilitation and sub-themes

Involvement facilitation

This involves keeping employees informed about the ICTs being adopted, while also encouraging their participation in the decision-making processes involving selection and implementation of these work-related ICTs (Ragu-Nathan et al., 2008). The thematic map in *Figure 4.15* summarises the main sub-themes associated with the involvement facilitation theme. These are described in *Table 4.27*, using participant narratives to support these descriptions.

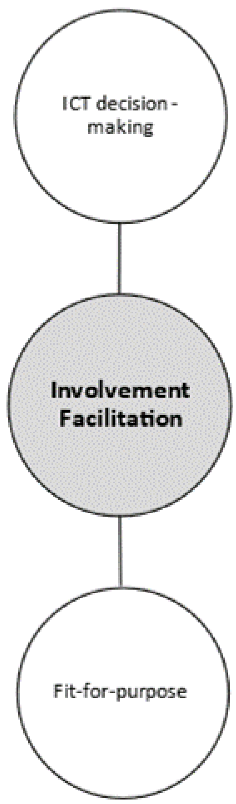

Figure 4.15 Thematic map of involvement facilitation and sub-themes

Sub-theme	Description	Supporting narrative(s)
Decision-making	Some participant narratives suggested that staff should be engaged in ICT selection and implementation in higher education workplaces, instead of being imposed on staff.	*"…staff and students need to be included in the discussions about what tech is used and why."* *"… central management must engage with staff when considering the adoption of new technologies."* *"We have very little choice in the use of some technologies, as they have replaced every other option, by which I mean if the university decides something new is to be used, it is to be used, and that's that."*
Fit-for-purpose	Some participants voiced concern that the lack of decision-making involvement of lecturing staff regarding ICT adoption may lead to the adoption of ICT that may not be fit-for-purpose.	*"Often the decision of what to use comes from higher up, from people who don't understand the use cases and are not fit to judge what tools are useful or not. This can lead to frustration if forced to use too many unfamiliar and unhelpful technologies."* *"Unfortunately a lot of new technologies introduced without input from the end user. Consequence is the technology is not fit for purpose."*

Table 4.27 Narrative excerpts for involvement facilitation and sub-themes

Technical support provision

This is the organisational support given to workers using ICTs in the workplace. Technical support provision emphasises the technical support that is offered to staff (Ragu-Nathan et al., 2008). While no distinct sub-themes were identified here, participant narratives indicated that there is a need for technical support in academic workplaces. Furthermore, what is apparent from some of the responses here is that technical support in contemporary university education is required not only for assistance in using digital technologies in education provision, but also extends to the requirement for support for online meetings. Some respondents reported their frustration at not having sufficient technical support available to them when using digital technologies:

“IT support is poor and sometimes I feel I have more chance of winning on the lotto than getting a response from IT support!”

This frustration was particularly evident in ‘emergency situations’, where IT failure may occur during teaching or meetings. Another respondent expressed concern about the impact that deficits in IT support have on the image of their employer university.

“Using digital technologies for teaching or even for important meetings can be very stressful, because of those occasions when the technology (inexplicably!!) does not work as it should, or as it has done before. In my experience, the local IT support for these "emergencies" is sadly lacking and needs to be addressed. A continued failure to do so will reflect poorly on the image of professionalism presented by the institution.”

4.8.3 Work performance

Respondents reported on a variety of ways in which they felt that digital technologies helped them in carrying out their work as university lecturers. The thematic map in *Figure 4.16* summarises the main sub-themes associated with the work performance theme. These are described in *Table 4.28*, using participant narratives to support these descriptions.

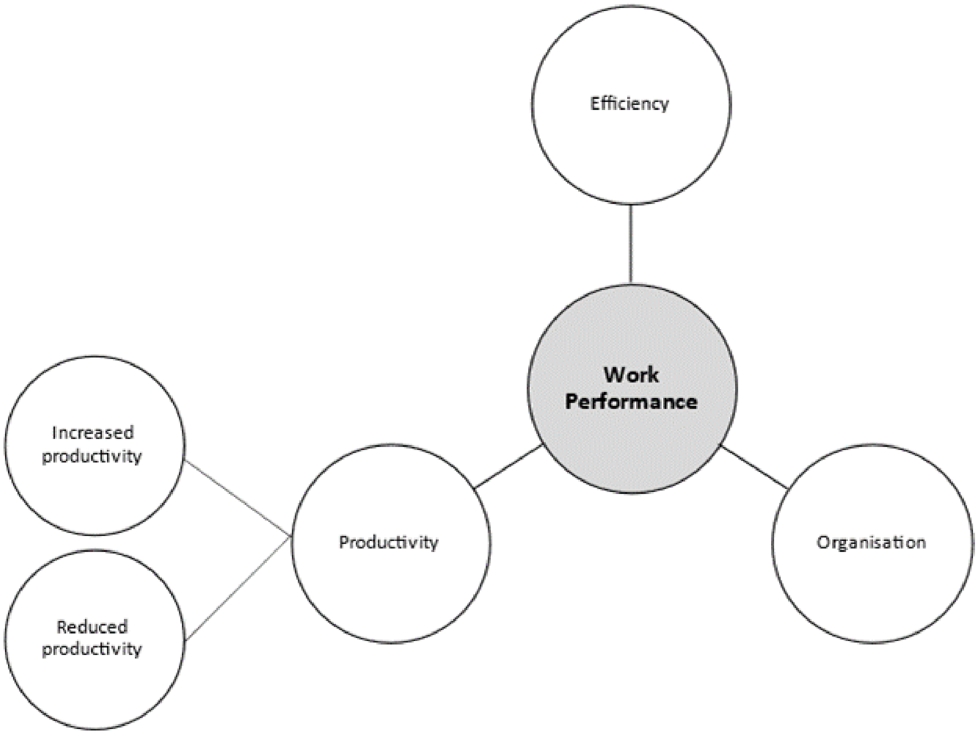

Figure 4.16 Thematic map of work performance and sub-themes

Sub-theme	Description	Supporting narrative(s)
Productivity	A number of participant narratives suggested that workplace technologies enhances their work productivity. One participant emphasised that educational technologies promote inclusion of lecturers with disabilities, helping them to maintain their work output. In contrast, one participant narrative suggested that educational technologies impair lecturer productivity.	***(a) Increased*** *"Productivity - being able to share notes with students, create/manage exam papers online, record student assessment grades online etc."* *"Ability to achieve more tasks in a more efficient and effective manner."* *"I am a lecturer with a disability and the use of digital technologies greatly enhances my work practice, student engagement and my work life balance. As a result of my disability I experience fatigue at the end of every workday and the use of digital technologies to manage my work helps me to manage work, in a field that I love, as best I can."* ***(b) Reduced*** *"The software is often clumsy, badly thought-out and inefficient. I might just get used to it and then there is an update which changes it again, sometimes causing long delays in productivity."*

Efficiency	Closely related to productivity, some participant narratives suggest that workplace ICT enhances their work efficiency.	*“Academic work is more efficient.”* *“It has been helpful in having meetings with individuals at locations off campus which saves the commuting time and can make it easier to find the time to meet others.”* *“Opportunity to multi-task during meetings when topics are not of relevance.”*
Organisation	A number of participants suggested that the use of ICTs in educational workplaces facilitate them in being organised in carrying out their work duties and responsibilities.	*“It helps me to keep track of what needs to be done.”* *“Helps organise and curate content. File keeping.”* *“Getting forms and booking rooms etc. is handy.”* *“Tracking of student engagement and information management.”*

Table 4.28 Narrative excerpts for work performance and sub-themes

4.8.4 Lecturer well-being

The main well-being measure used in this study was work-related burnout. While only one participant directly referenced burnout, it is apparent from some participant narratives that a technology-enabled higher education occupational setting has an influence on the personal well-being of lecturers in ways that are potentially related to burnout. A number of participants report that advantages of using digital technologies for work include enhanced work flexibility, ability to work remotely, reduced commuting time and associated financial costs. A few respondents also reported that it *"Makes life easier".* However, one participant found technology-related stress so unbearable that they left their lecturing position:

> *"I enjoy my work less than I used to, to be frank. I find it's more automated and less intimate in a way. There are some efficiencies but for me they are more than eclipsed by the lack of real human contact. This is very necessary to create team spirit, effectively communicate and in order for me to feel a sense of belonging. I have recently taken on a new role specifically to get away from lecturing for these reasons, which is terribly sad!"*

4.8.5 Other themes

Two additional themes emerged strongly from the participants' narrative responses. These were the student experience and communication.

Student experience

Despite the questionnaire statement being directed at eliciting the experiences of lecturers using digital technologies, some participants also reported on their perceptions regarding the impact of educational technologies on the student experience and engagement. While narratives related to inclusivity were all positively disposed towards the role of educational ICTs in promoting inclusion of students in educational environments, some participants ascertained that digital learning enhanced student engagement, while others decried digital learning as being a negative influence on student engagement. The responses regarding the feedback-enhancing capabilities of digital technologies were similarly mixed. The thematic map in *Figure 4.17* summarises the main sub-themes associated with the student experience theme. These are described in *Table 4.29,* using participant narratives to support these descriptions.

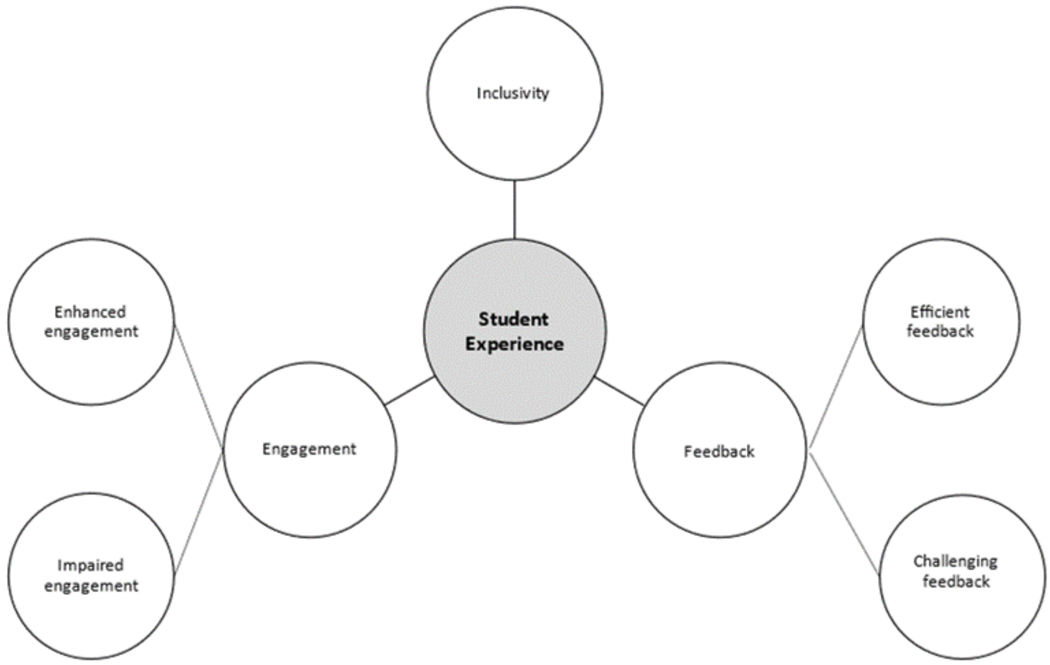

Figure 4.17 Thematic map of student experience and sub-themes

Sub-theme	Description	Supporting narrative(s)
Inclusivity	Some participants reported that they considered the use of digital technologies for educational purposes as beneficial for promoting the educational inclusivity of students.	*"It make the learning process more inclusive."* *"Making education more accessible as a whole."* *"Digital technology allows different approaches all at the same time. It facilitates a more universal design led approach."* *"Students have access to the powerpoint presentation…very beneficial to students with diverse neurologies."* *"Opens up so many more possibilities. Can reach students who are experiencing difficulties as can use live face and asynchronous methods - it enables greater participation and means that missing a class doesn't mean missing out because of the ability to share notes and recordings of lectures in one accessible space."*
Feedback	Some participants suggested that student feedback was enhanced by using ICTs. However, one participant challenged that individual feedback is hampered in an online environment.	*(a) Efficient* *"Efficient ways to give student feedback and to assess work."* *(b) Challenging* *"Individualised feedback is difficult online."*

Engagement	Participants had mixed views on the benefits of digital technologies on student engagement. Some suggested that such technologies enhance student engagement, while others suggested that they hamper student engagement.	*(a) Enhanced* *"It allows us to compete for learners cognitive bandwidth in there very digitally influenced world."* *"Other benefits include: making the teaching and learning more engaging, interesting and interactive for students."* *(b) Impaired* *"Digital learning appears to impair the quality of the learning for the Student. "* *".. video tutorials of various tasks in my courses… provided students with additional good reference for material covered in class. However, if anything it also resulted in the students doing less work."* *"Students think they can work independently using digital resources provided, often not committing enough time and effort to modules."*

Table 4.29 Narrative excerpts for student experience and sub-themes

Communication

Communication has also emerged as a strong theme in the analysis of the respondent narratives. The thematic map in *Figure 4.18* summarises the main sub-themes associated with the techno-overload theme. These are described in *Table 4.30*, using participant narratives to support these descriptions.

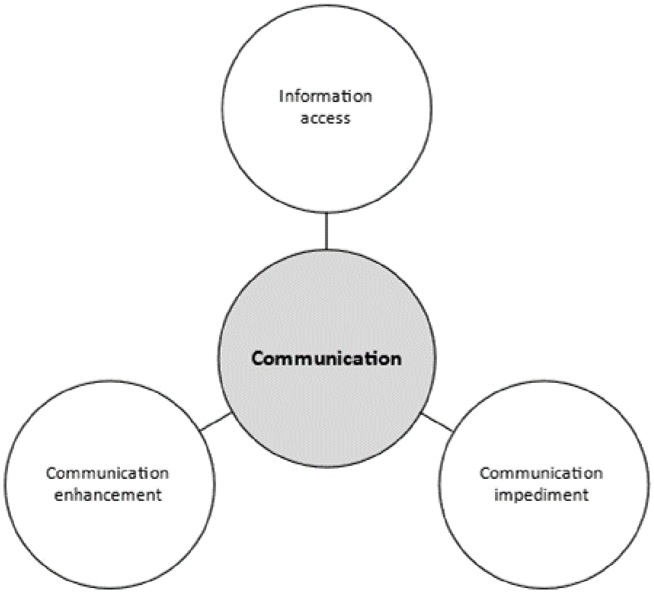

Figure 4.18 Thematic map of communication

Sub-theme	Description	Supporting narrative(s)
Information access	Some participant narratives suggested that digital technologies promote access of digital information for students. Digital facilitation of lecturer access to student work was also considered beneficial.	*"I do find that technology makes it easier to access information."* *"Gives you a way to keep connected with students. They have access to notes and quizzes. I have access to their submitted work."* *"Learning management systems make organising classes, sharing materials and communicating with students so much easier."* *"Technology is good for disseminating information in a consistent manner, giving a clearer message."*
Communication enhancement	A number of participant narratives described how digital technologies enhance communications in the academic workplace. Enablement of communication across geographical separations, locally, nationally and internationally, promoting more time for communication and supporting the inclusion of more people in meetings and collaborations was highlighted.	*"Easier ways to connect with students/colleagues that you are not collocated with"* *"It has been helpful in having meetings with individuals at locations off campus which saves the commuting time and can make it easier to find the time to meet others."* *"Communication between myself and my students is easier using the technology.*

Communication impediment	A smaller number of participant narratives described digital technologies as workplace communication barriers. One participant reported feeling deprived of non-visual cues when in the online environment, while another claimed that communicating primarily online increased the professional distance between them and their managers.	*"Overall, there is 'more' communication but it's less efficient, less enjoyable and less productive. This adds to my workload, frustrates me and diminishes the sense of enjoyment and fulfilment I derive from my work."* *Managers can be more distant and hide away from staff.* *I feel the lack of face-to-face time with the students and colleagues in person can sometimes lead to problems in understanding body language and the subtle nuances that occur outside of virtual life.*

Table 4.30 Narrative excerpts for communication and sub-themes

Chapter 5: Discussion

5.1 Overview

Rapid technological developments have fundamentally changed information production and consumption in higher education landscapes, as ICT allows for fast access to information, irrespective of space and time (Govender & Mpongose, 2022). University lecturers are therefore required to engage in ongoing upskilling and adaptation to the extensive use of ICTs in higher education workplaces. This exploratory study framed the examination of the technostress creators as job demands experienced by Irish university lecturers within Demerouti et al.'s (2007) Job Demands-Resources model. The relationships between these job demands and work-related burnout, as a measure of employee well-being, and work performance were also explored. Technostress inhibitors, as organisational measures to mitigate against the negative effects of technostress creators in Irish university workplaces, were also probed. The Irish higher education system was the context for this study.

This Discussion chapter emphasises consideration of the quantitative questionnaire findings, probing these findings with reference to technostress and education literature. Participant narrative contributions in response to the open-ended statements at the end of the questionnaire facilitated a more in-depth understanding of some of the quantitative findings, while also allowing for the identification of other possible contributors to, and mitigators against, technostress in Irish academic work environments. Consideration of both the quantitative findings, and the narrative responses, allowed for a more comprehensive overview of the factors related to the cause and reduction of technostress in Irish HEI contexts. These findings can also be used to inform university management decision-makers about Irish HEI workplace characteristics that are likely to result in a negative experience of technostress by Irish university lecturers, while also creating an awareness of possible technostress mitigation measures that may be adopted at an organisational level.

This chapter presents the key study findings associated with each of the Research Questions, followed by an overview of the contributions to the literature made by this study, limitations of the study, and suggestions for further research into the phenomenon of technostress experienced by employees in Irish higher education institutions.

5.2 Key findings

This section addresses each Research Question in turn, by briefly summarising the key findings of this study, and exploring them within the context of the literature.

5.2.1 Research Question 1

"Which are the predominant technostress creators experienced by a sample of Irish university lecturers?"

Mean technostress creator sub-scale scores were considered when addressing Research Question 1. The techno-uncertainty measure was excluded from consideration due to its failure to meet the stated psychometric reliability threshold (Section 4.3.2). The existence of differences in mean scores between technostress creator sub-scales as found here is consistent with findings from previous studies (e.g., Ragu-Nathan et al, 2008; Tarafdar et al., 2015; Li & Wang, 2021; Hang et al., 2022). The techno-overload scale had the highest mean score (3.24±1.03) of the technostress creator sub-scales. This was followed by means scores of techno-invasion (2.98±1.28), the combined technostress creator measure (2.84±0.67), techno-complexity (2.63±0.99) and techno-insecurity (1.77±0.77). This rank-order of descending technostress creator sub-scale means is consistent with that found by Andrulli and Gerard (2023) in a general Dutch worker population, as well as Wang and Zhao's (2023) technostress creator measures in a sample of Chinese secondary school teachers.

The technostress creator sub-scale scores are now considered individually for each of these sub-scale measures. Wang and Zhao (2023) proposed that Likert score values of above ‘3’ be classified as “upper-middle”, while those lower than ‘3’ be classified as “lower-middle” scores. This classification approach was adopted here in the absence of any other standardised classification of Likert score values.

Techno-overload

The mean techno-overload score (3.24±1.03), an upper-middle score, reflects a high level of techno-overload. Closer scrutiny of the individual scale items (*Table 4.9*) associated with mean scores in this upper-middle range elicits further detail about the main contributors to techno-overload as experienced by this sample of Irish university lecturers. Each of these items, reported here with their mean scores, is considered separately below.

“I am forced to change my work habits to adapt to new technologies” (3.81±0.15)

Ragu-Nathan et al. (2008) proposed that being forced to change work habits, with the consequent requirement for longer working hours, is associated with high levels of techno-overload. Li and Wang (2021) further suggested that increased ICT-related work demands require university teachers to work faster during these longer working hours. Such changed working habits associated with high levels of workplace ICT use have also been highlighted by Califf and Brooks (2021). They proposed that an additional contributor to ICT-related increased workloads is the requirement for educators to act as change agents, altering their educational practices to incorporate educational technologies. This suggests that technological disruption of the educational space fundamentally changes how educators do their jobs. Being required to work for longer periods of time due to high ICT-enabled workloads was also identified as a techno-overload sub-theme (*Figure 4.11*) in analysis of the participant narratives.

Participant narratives in this study further highlighted the high volume of electronic communications that Irish university lecturers are expected to manage, and respond to, results in increased workloads and associated lengthening of working hours. The literature also identified this requirement to engage with multiple ICT formats, and communications applications, as a possible cause of techno-overload. Such communication overload is often associated with social overload, arising from the expectations that lecturers maintain a virtual world presence, involving receipt and response to frequent notification from virtual learning environment and social networking apps. Paying attention to this constant information influx is challenging, leading to increased levels of technostress (Alvarez-Risco et al., 2021; Rasool et al., 2022). This constant stream of information requires a higher level, and faster pace of cognitive information processing, over longer periods of time (Tarafdar et al., 2007; Tarafdar et al., 2011). Cognitive overload arises as the individual struggles to deal with the demands of the deluge of information and the prioritisation of this information, possibly resulting in reduced individual well-being and work productivity (Schmitt et al., 2021).

"I have a higher workload because of increased technology complexity" (3.64±1.27)

Although techno-complexity is discussed later in this chapter, it is recognised here that the complexity of workplace ICT can result in a higher workload. This was also reflected in a participant narrative contribution: *"Some technologies increase your workload instead of simplifying it."* Other participant narrative responses also allude to the contribution of technological complexity to the techno-overload experienced by university lecturers. They suggest that having to support students in mastering the complexity ICT systems, production of electronic teaching and learning materials and requirements to shoulder higher administrative loads further contribute to the complexity of their work and the time taken to complete these work responsibilities.

"I spend less time with my family due to work-related technology" (3.08±1.37)

Results of Rasool et al.'s (2022) literature review on workplace-associated technology overload showed that other contributors to technology overload in the workplace may also include frequent interruptions, work-life conflict and work-family conflict, thereby evidencing the negative effects of increased workloads invasion of out-of-work time and the effects it may have on non-work relationships during this time. This reflects the close alignment of the technostress sub-constructs of techno-overload and techno-invasion, as suggested by Li and Wang (2021), with techno-invasion being discussed in more detail next.

Techno-invasion

The mean techno-invasion score (2.98±1.28) could be deemed to be on the border between Wang and Zhao's (2023) 'lower-middle' and 'upper-middle' technostress classification. This reflects a moderate level of techno-invasion but was scrutinised more closely here due to its close association to techno-overload. Closer scrutiny of the individual scale items (*Table 4.9*) associated with mean scores in this upper-middle range elicits further detail about the main contributors to techno-invasion as experienced by this sample of Irish university lecturers. Each of these items, reported here with their mean scores, is considered separately below.

"I have to be in touch with my work even during my holidays due to work-related technology" (3.13±1.52)

The experience of techno-invasion as a contributor to technostress, arises out of expectations that workers are constantly available, and connected to work, contactable at all times by those in their workplace (Tarafdar et al., 2007; Tarafdar et al., 2010). Even when employer policies facilitate the right-to-disconnect, the extent of the workload may make it feel like such disconnection from work for periods of time is unfeasible, as shown suggested by one of the participant narratives: *"I know we have the right to disconnect outside of work hours but with the volume of work, coupled with the ability to engage with work outside core hours, it is almost impossible to do so effectively and with consistency".*

"I feel my personal life is being invaded by work-related technology" (3.13±1.47)

Educator experiences of techno-invasion arises from their perception that work-related technology is contributing towards the blurring of the boundaries between work and non-work (home) life. This may lead to a feeling that these technologies interfere with the educator's personal life and family time (Califf & Brooks, 2020). This is also reflected in the techno-invasion sub-themes (*Figure 4.12*) identified from the participant narratives. These suggest that manager expectations of longer working days also contribute to techno-invasion in academic jobs, particularly with regards to expectations that lecturers will engage in email communications with students at all times of the day and night, thereby invading lecturer personal time. Some participants reported that there were expectations that lecturers should expect to have their rest and recovery periods interrupted by technologically-facilitated work-related tasks.

Techno-complexity

The mean techno-complexity score (2.63±0.99) is at the upper end of the lower-middle classification of technostress. Closer scrutiny of the individual scale items (*Table 4.9*) identified a single item with an upper-middle score, as described below.

"I do not find enough time to study and upgrade my work-related technology skills" (3.36±1.23)

This item aligns closely with the description of techno-complexity in the literature. Tarafdar et al. (2007) and Tarafdar et al. (2011) describe this technostress sub-construct as arising out of worker perception of overwhelm due to the demands of workplace ICTs, and the expectation that workers will attain and maintain ICT-related proficiencies and associated efficiencies. These time demands associated with ICT-upskilling were also identified as the pace of technological change, and the associated need to frequently upskill, was also identified as an additional techno-complexity sub-theme (*Figure 4.13*) from these narratives.

Techno-insecurity

The mean techno-invasion score (1.77±0.77) is the lowest of all the technostress creator scores, also positioned within the lower-middle classification of technostress severity. None of the individual questionnaire items measuring techno-insecurity were identified as having means in the upper-middle range (*Table 4.9*). The low mean score for this technostress creator could be due to the likelihood that many of the respondents are relatively confident in their digital skills and have permanent tenure in their positions, thereby giving them a sense of employment and income security, despite technological advancements and changes. No themes identifying factors contributing to techno-insecurity were identified from participant narratives, although one participant did note that *"The assumption that a new shiny piece of technology is always an improvement on the established techniques is a real threat. It's too easy to discount teaching experience and the lecturers who have the experience in place for the "killer app" which really doesn't improve anything."* This reflects the essence of techno-insecurity, which is a fear of being replaced by other workers with greater ICT proficiencies or being replaced by the ICT systems themselves (Tarafdar et al., 2007). Califf and Brooks (2020)'s study on technostress experiences of teachers suggested that educators experiencing high levels of techno-insecurity are likely to withhold information from colleagues and avoid collaboration, thereby fostering a negative workplace environment, which may ultimately compromise student outcomes.

It should be noted that the data collection for this study was completed prior to the widespread promotion and awareness of Chat GPT, an artificial intelligence chatbot developed by OpenAI (https://openai.com/blog/chatgpt). The easy availability and use of this chatbot has prompted a wave of concern and extensive debate in higher education about the potential implications of using such large language models for higher education teaching, learning and assessment (e.g., Arif et al., 2023; Tlili et al., 2023). It is possible that the techno-insecurity scores in this questionnaire may have been higher, had the survey for this thesis been conducted since the advent of Chat GPT and other large language models.

5.2.2 Research Question 2

"Are there differences in levels of technostress of a sample of Irish university lecturers as defined by demographic variables of age, gender and level of education?"

This research question was considered individually for each of these participant demographic factors, as described below.

The technostress creator-age relationship (Hypothesis 1)

The 26-to-35-years age group had the highest mean techno-invasion score (3.38±1.35) (*Table 4.14*). This group also had the highest mean techno-insecurity score (2.11±1.08). The 46-to -55-years age group scored most highly on the techno-overload (3.03±1.01) and overall mean technostress score (2.67±0.66). The 56-to-65-years age group had the highest mean score for techno-complexity (2.69±0.96). These findings suggest that the 26-to-35-years age group are most affected by technology invading their non-work time, which may be due to this being the age group that is most likely attempting to become established and recognised in their academic disciplines and careers. This could also be a factor in this group's highest mean techno-insecurity score, as they could feel unsettled and fear being replaced, or losing out on long-term contracts or promotions. That the 46-to-55-years age group experiences the highest techno-overload could reflect the likelihood that this group are employed in positions with higher-level responsibilities, such as those associated with roles encompassing academic management responsibilities. They are also the age group most likely to be experiencing the negative effects of heavy workloads associated with caring responsibilities for both younger and older family members, leading to higher perceptions of heavy workloads due to ICT-facilitated remote work access allowing for longer working days and management of heavy workloads around caring responsibilities.

The highest mean score for techno-complexity in the 56-to-65-years age group reflects the likelihood that this age group is most challenged by ICT developments in the workplace, and the associated need to upskill to be able to meet expectations associated with ICT-related work demands. These higher mean scores for techno-overload and techno-complexity concur with Tu et al.s' (2005) and Marchiori et al.'s (2019) findings that employees over the age of 35 years are more likely to experience technostress associated with these technostress creator sub-constructs. Tu et al. (2005) suggested that higher techno-complexity scores in older age groups could be associated with a greater resistance to change, but also to a reduced cognitive processing ability, meaning that ICT-related demands are more challenging to manage.

Despite the differences described here, these inter-age group differences in technostress creator score means failed to demonstrate statistical significance in this study. This lack of a statistical association between age and technostress creators is supported by La Torre et al.'s (2020) findings of a lack of a significant association between age and techno-invasion, techno-complexity and techno-insecurity, respectively.

The technostress creator-gender relationship (Hypothesis 2)

The mean techno-invasion scores were similar for both male (2.97±1.26) and female (3.00±1.29) participants (*Table 4.16*). The mean overall technostress creator scores were also similar for male (2.83±0.71) and female (2.84±0.66) participants. The mean techno-overload score for male participants (3.46±1.01) was slightly higher than that of female participants (3.07±0.98), reflecting upper-middle scores for both these technostress creator sub-scales. This concurred with Asad et al.s' (2023) findings. The mean techno-complexity score was higher for female participants (2.78±0.92), compared to male participants (2.35±1.02), concurring with Marchiori et al.'s (2019) findings. Similarly, the mean techno-insecurity score was also higher for female participants (1.87±0.72) than for male participants (1.66±0.84). The findings here contrast those of Ragu-Nathan et al. (2008), reporting that males experience greater technostress than females do, while Gabr et al. (2021) and Vergine et al. (2022) reported higher levels of technostress in females.

None of these differences were found to be statistically significant. This is consistent with Wang et al.'s (2008), Qi's (2019) and Ozgür's (2020) findings of a lack of a relationship between gender and technostress creator scores.

The technostress creator-level of education relationship (Hypothesis 3)

Lecturers with a highest qualification at Masters level have the highest overall technostress creator (2.97±0.65), techno-overload (3.30±0.93) and techno-complexity (2.82±0.90) scores (Table 4.16). Only the techno-complexity mean score for Master's degree holders falls within the 'upper-middle' range. Techno-invasion (3.83±1.65) and techno-insecurity (2.38±0.18) scores were highest for participants with Honours' degrees, with the former falling within the 'upper-middle' range. However, it should also be noted that there were only two participants who reported possessing Honours degrees as their highest qualification. None of these differences were found to be statistically significant. The literature similarly shows a lack of a statistically significant relationship between highest educational level and technostress. This is consistent with the findings of Wang et al. (2008), Shu et al. (2011) and Marchiori et al. (2019).

Although these findings were considered with reference to previous publications, and the diversity of findings in the study of the relationship of these demographic factors to technostress creators, it is important to acknowledge that the drivers of the technostress creators are going to present different challenges in different work environments. It is therefore important to consider technostress scores, and their relationship to these demographic factors, as being unique to the context of each individual study. The need to consider technostress with reference to unique occupational environments has been highlighted in the literature, e.g., Atanasoff and Venable (2017), Borle et al. (2021), Berg-Beckhoff et al. (2021).

5.2.3 Research Question 3

"Do relationships exist between measures of technostress creators, work-related burnout and work performance of Irish university lecturers?"

This research question was explored through the testing of the relationships proposed by *Hypotheses 4* to *7*.

The technostress creator-work performance relationship (Hypothesis 4)

The results of the linear regression analyses in the study described here show that only the overall technostress measure, techno-complexity and techno-overload negatively predict work performance, represented by measures of work productivity and work innovation. Furthermore, the results here suggest that techno-complexity is responsible for the most variance in work performance, with total technostress and techno-overload measures having a lesser influence on work performance of university lecturers. These analyses showed no predictive effect of techno-invasion and techno-insecurity on work performance, suggesting that these technostress creator sub-construct measures have no influence on work performance of university lecturers. These findings are consistent with Zhao et al.'s (2022) assertion that the relationship between techno-stressors and work productivity depends on the type of technostress creator under consideration.

The negative relationship between total technostress and work performance demonstrated here is consistent with Tarafdar et al.'s (2007) finding of a negative relationship between total technostress and productivity, as well as Tarafdar et al.s' (2015) finding of a negative relationship between total technostress and technology-enabled innovation. Similarly, the results here align with Yener et al. (2021) showing that a negative relationship exists between a total technostress measure, and both task and contextual performance, as well as Iannou et al.'s (2022) findings of a negative relationship between a total technostress measure and end-user performance.

The negative relationship between techno-complexity and work performance, and techno-overload and work performance, concur with those of Taradfar et al. (2011), who also demonstrated a negative relationship between techno-complexity, techno-overload, and task productivity, respectively. They are also consistent with Li and Wang's (2021) findings of a negative relationship between techno-complexity and work performance of university teachers, and Qi's (2019) findings of a negative relationship between techno-complexity and academic performance, as well as techno-overload and work performance, in university students. This suggests that the higher the levels of complexity of work-related ICT, generating an increased requirement for university lecturers to upskill to attain and maintain digital proficiency and efficiency, the greater the associated reduction in work performance of the lecturer. This is likely to be due to the increased work-load and associated techno-overload perceived by university lecturers regarding expectations that they engage in digital skills capacity building. This is reflected in the negative predictive relationship identified here between university lecturer perception of techno-overload and their work performance.

The techno-overload findings here are in contrast with Li and Wang's (2021) finding of a positive relationship between techno-stressors and work performance, as well as Tu et al.'s (2005) and Hung et al.'s (2015) findings of a positive relationship between techno-overload and work productivity. The contrasting findings here could be explained with reference to the Yerkes-Dodson Law (Karr-Wisniewski & Lu, 2010; Hung et al., 2015), whereby optimal task performance occurs at an intermediate level of arousal, such as when exposed to an environmental stressor, with poorer performance at both lower and higher levels of arousal. This results in an inverted U-shaped relationship between arousal and task performance (Colman, 2015), with the direction of the relationship between ICT-related stress and work productivity being dependent on the level of stress experienced, which is likely to be individual for each worker. Accordingly, a moderate level of technostress can contribute to improved performance, whereas low or high levels of technostress degrade performance

(Rohwer et al., 2022). The Yerkes-Dodson Law therefore demonstrates that a positive relationship can exist between ICT and productivity, but that this reaches a threshold, at which the usability of these technologies in promoting productivity is surpassed, followed by a decline in productivity associated with ongoing technological demands. When considered in light of this Yerkes-Dodson Law, the negative relationship between techno-overload and work performance in this study suggests that many of the participants are experiencing levels of technology-related stress that surpasses the threshold response, with excess levels of such stress leading to reduced work performance.

The findings of a lack of a significant relationship between techno-invasion and work performance here is likely due to the facilitation of management of the academic workload and work performance expectations through techno-invasion. This suggests that techno-invasion may facilitate maintenance of work performance. However, the findings of the lack of a significant relationship between these variables is in contrast with Qi's (2019) findings of a significant negative relationship between these variables in a sample of university students.

The lack of a significant relationship between techno-insecurity and work performance as shown here is likely due to the security of tenure enjoyed by many university lecturing staff responding to this survey, thereby negating the possibility of being replaced by others in the workplace. The lack of a significant relationship between techno-insecurity and work performance is similarly inconsistent with Li and Wang's (2021) findings of a negative relationship between these variables. These findings also contrast with Tu et al.'s (2005) and Tarafdar et al.'s (2011) identification of a negative relationship between techno-insecurity and productivity. Future consideration should be given to whether large language models are likely to promote or hinder techno-insecurity perceptions of university lecturers.

The technostress creator-work-related burnout relationship (Hypothesis 5)

Work-related burnout was used in this study as an indicator of university lecturer well-being (Alarcon et al., 2011). The results of the linear regression analyses here show that the total technostress measure, techno-overload, techno-invasion and techno-complexity positively predict work-related burnout. Furthermore, the results here established that techno-overload is responsible for the most variance in work-related burnout, with total technostress, techno-invasion and techno-complexity measures having a lesser influence on work-related burnout. This suggests that higher levels of these main and subconstructs of technostress creators would result in higher levels of work-related burnout of university lecturers, particularly with regard to higher ICT-related and facilitated workloads, and the longer working hours expected from university lecturers as a result of this. These analyses showed no predictive effect of techno-insecurity on work-related burnout.

These findings concur with Califf and Brooks' (2020) finding of a positive relationship between techno-overload, and techno-invasion and burnout, respectively. The findings also align with Kasemy et al.'s (2022) conclusion that techno-overload is the strongest technostress creator predictor of burnout in medical staff, followed by techno-invasion, then techno-complexity. Delpechitre et al. (2019) also found an inverse relationship between techno-overload and work performance. The findings of a positive relationship between technostress creators and burnout further concurs with the findings of Srivastava et al. (2015), Pflügner et al.(2021), Yener et al.'s (2021), Kasemy et al. (2022) and Zhao et al.'s (2022). This is also supported by Berg-Beckhoff et al.'s (2017) literature review findings indicating a trend of positive associations between workplace ICT usage and burnout. As exhaustion is a recognised component of burnout (Schaufeli & Greenglass, 2001; Maslach, 2001; Kristensen et al., 2005), studies incorporating the investigation of the relationship between technostress and exhaustion are also considered here in the interpretation of the results of the study described here. The findings of a positive relationship between technostress and burnout align with Alvarez-Risco et al.'s (2021) finding of a positive association between technostress and exhaustion when studying the influence of technostress on the academic productivity of medical students. This is also consistent with Braunheim et al.'s (2022) findings of a positive relationship between technostress and exhaustion. These findings suggest that Irish university lecturers are therefore at increased risk of burnout due to technostress creators. This is consistent with the basic premise of the Job Demands-Resources model, whereby occupational stress can lead to burnout along the health impairment pathway (Demerouti et al., 2001).

The work-related burnout-work performance relationship (Hypothesis 6)

Linear regression analysis suggested that work-related burnout is a predictor of work performance, as represented by measures of work productivity and work innovation, in a negative, linear manner. This suggests that higher levels of work-related burnout would lead to lower levels of work performance of university lecturers. This aligns with Amer et al.'s (2022) study conclusion that reduced job performance is a consequence of burnout in university occupational settings. It also concurs with Yener et al.'s (2021) findings of a negative relationship between burnout and task and contextual performance, respectively and is consistent with Alvarez-Risco et al.'s (2021) finding of a negative relationship between exhaustion and academic performance of medical students.

Burnout as a mediator of the technostress creator-work performance relationship (Hypothesis 7)

Mediation analysis findings suggest that work-related burnout explains the negative relationship between techno-invasion and work performance only. This concurs with Bakker et al.'s (2004) findings that exhaustion (as a measure of burnout) partially mediates the relationship between work demands and job performance. Similarly, Alvarez-Risco et al. (2021) demonstrated a mediating effect of exhaustion on the technostress–academic performance relationship in university students. No such mediating effect of work-related burnout was found between the total technostress measure, techno-overload, techno-complexity, techno-insecurity, and work performance, respectively. These findings concur with Yener et al.s' (2021) lack of a significant mediation effect of burnout between technostress creators and both task and contextual performance respectively.

5.2.4 Research Question 4

"Do technostress inhibitors have a role to play in the relationships mentioned in Research Question 3?"

This research question was explored within the context of *Hypotheses 8* and *9*. Technostress inhibitors are organisational interventions intended to reduce technostress, thereby promoting productivity associated with ICT usage in the workplace. The technostress inhibitor measures in this study were: mean overall technostress inhibitor; techno-facilitation (a combined literacy facilitation and involvement facilitation measure); technical support provision. These technostress inhibitors are most effective when these interventions successfully address the needs of employees in mitigating against ICT-induced stress (Ragu-Nathan et al., 2008). While the technostress creator and technostress inhibitor measures were consistent across all analyses when testing both *Hypotheses 8* and *9*, their product (interactive effect) and its relationship to either work performance or work-related burnout was considered when considering and discussing these findings.

Technostress inhibitors as moderators of the technostress creator-work performance relationship (Hypothesis 8) and the technostress creator-work-related burnout relationship (Hypothesis 9)

The findings show that the mean overall technostress creator measure does not demonstrate any significant interactions with any of the technostress inhibitor measures in predicting either work performance or work-related burnout. This supports the separate consideration of each of the technostress creators in their interactions with technostress inhibitors and their effects on work performance and work-related burnout. The following significant moderation effects were identified in this study:

- The mean overall technostress inhibitor measure was shown to moderate the techno-complexity–work performance relationship in a negative direction. This suggests that technostress inhibitors, when considered in combination, enhance the negative techno-complexity–work performance relationship, instead of reducing this negative relationship (*Figure 4.6*). Technostress inhibitors therefore promote a further reduction in work performance of university lecturers perceiving techno-complexity in their work environments.
- Techno-facilitation was found to moderate the techno-complexity–work performance relationship. This suggests that techno-facilitation enhances the negative techno-complexity–work performance relationship, instead of reducing this negative relationship (*Figure 4.7*). Techno-facilitation, consisting of literacy facilitation and digital literacy measures, therefore promote a further reduction in work performance of university lecturers perceiving techno-complexity in their work environments.
- The mean overall technostress inhibitor measure was found to moderate the techno-invasion–work-related burnout relationship. That this interaction was positive, suggests that the overall level of technostress inhibition further strengthens this relationship between techno-invasion and work-related burnout, representing an exacerbation, instead of the expected mitigation, effect (*Figure 4.8*). Technostress inhibitors, as a combined measure, therefore promotes a further increase in work-related burnout of university lecturers perceiving techno-invasion associated with their work environments.
- Technical support provision was shown to moderate the techno-overload–work-related burnout relationship. The positive relationship between techno-overload and work-related burnout is weakened through technical support provision as a technostress inhibitor (*Figure 4.9*). Technical support provision therefore functions to reduce work-related burnout due to techno-overload. This is the only technostress creator-technostress inhibitor interaction relationship in this study that demonstrated the expected mitigation effect.

No other statistically significant moderation effects were identified. The lack of a mitigating effect of techno-facilitation on reducing the respective relationships between techno-overload, techno-complexity, techno-invasion, and work-related burnout concurs with Hang et al.'s (2022) failure to demonstrate an interactive effect between techno-overload and involvement facilitation, and techno-complexity and involvement facilitation in a sample of banking employees.

The findings suggest that the overall measure of technostress inhibition and the sub-scale of techno-facilitation seem to promote technostress, instead of alleviating it. As the techno-facilitation measure used here encompasses measures of both literacy and involvement facilitation, these findings suggest that the organisational initiatives currently used in the Irish university workplaces to train, involve and engage lecturing staff in the use and adoption of workplace technologies seem to have the effect of promoting the reduction, instead of expected increase, in work performance due to techno-complexity. This apparently contradictory finding could be explained by the possibility that – where such training and involvement is offered – it is not in sufficient quantity or type. ICT training is often delivered in organisations in formal, defined units, aimed at addressing the ICT-related needs of a group of people within that organisation. Employees are then challenged to try to find the time in their existing heavy workloads, to engage with training and involvement initiatives, which then compete with the time that lecturers can dedicate to other aspects of their work, thereby reducing their overall work performance. Furthermore, these time demands associated with engaging with the technostress inhibitor mechanisms, when considered in addition to techno-overload and heavy workloads in general, may be managed by the lecturer by extending work into non-work time, increasing the perception of techno-invasion.

When considering the results at the level of the individual survey item, the mean scores for most techno-facilitation questions are within the upper-middle range. The means of two of these items are in the lower-middle range. The lower-middle range mean score for the item *"Academic staff are involved in work-related technology introduction, change and/or implementation"* suggests that there is scope for an increased active involvement of university lecturing staff in the selection and introduction of new technologies. This is supported by participant narratives, further suggesting that the perceived imposition of technologies on academic staff, without any consideration of whether these technologies are fit-for-purpose can lead to frustration, thereby further exacerbating ICT-related stress, as shown by the following narrative: *"Often the decision of what to use comes from higher up, from people who don't understand the use cases and are not fit to judge what tools are useful or not. This can lead to frustration if forced to use too many unfamiliar and unhelpful technologies."*

Furthermore, these participant narratives may give insight into the types of training that should be considered as part of techno-facilitation and digital literacy enhancement measures. With regards to the types of training, one of the participants suggested that training on the use of the software is not sufficient on its own, and that pedagogical training appropriate to delivering educational material online, using these technologies, is also required. Other respondent narratives suggest that a more informal, accessible and responsive form of training is desirable, with suggestions of a system of digital mentorship to facilitate university lecturers in navigating new workplace technologies in the spaces that they are being used. For example: *"…we need mentors to show how we could use available tech in class etc…"* Employees should be encouraged to share technical knowledge as a way of reducing the adverse effects of technostress (Califf & Brooks, 2020). Due to the rapidly-evolving nature of educational technologies, consideration should also be given to supporting lecturers returning to work after a period of absence, as they might need support in upskilling in education technologies, as demonstrated by the participant narrative: *"Getting back to work after a career break was very tricky, a technology mentor would have been an excellent help…"* Such mentoring systems have the added advantage that the individual lecturer could feel more in control of the timing of such digital training interventions, availing of them when and where needed, rather than having to find time to attend for formal ICT training events that may only partially address their specific ICT training needs. The adoption of a digital mentoring system for educators has also been suggested in the literature (e.g., Aktan & Toramen, 2022).

Digital literacy development can be enhanced by providing both guidance and training for staff in the efficient use of new ICT systems (Jena, 2015). The importance of providing training and support for the adoption of educational technologies should be emphasised. There are advantages of such training for both the individual university employee, and their employer HEI. The enhancement of employee knowledge, skills and abilities related to workplace technologies can support the employee's ability to cope with workplace stress, as well as improving their overall work performance, and – by extension – the organisation's performance. Failure to provide relevant training for staff may result in unwanted work outcomes, such as the inability to perform as per requirements to meet the organisational goals (Saleem et al., 2021). Inviting university staff to participate in the planning, implementation, assessment, and refinement phases of new ICT integration into HEIs may reduce their technostress due to consideration of the actual ICT requirements and need for their work (Tarafdar et al., 2010; Califf & Brookes, 2020). Involving university lecturers in these decision-making processes gives them a voice in the design and selection of system requirements.

Communicating changes, benefits and opportunities regarding the introduction of new technologies may also reduce technostress (Jena, 2015). The low mean score for the item *"Academic staff are rewarded for using new technologies"* suggests that a reward system, whereby academic staff are rewarded for the use of new technologies, could promote increased techno-facilitation scores, which might have a greater mitigation effect against the technostress creators in academic work environments. I suggest that these rewards can be in the form of academic recognition, such as digital badges, and by achieving recognition for the adoption of new educational technologies through inclusion of this as a criterion for academic promotion.

The findings here that technical support provision reduces the positive relationship between techno-overload and work-related burnout concurs with Hang et al.'s (2022) finding of a significant interactive relationship between techno-overload and technical support provision in reducing the negative influence of techno-stressors on employee well-being. This finding emphasises the importance of maintaining an accessible and efficient ICT help desk, staffed by IT experts, to support employees in undertaking their work responsibilities (Jena, 2015; Rohwer et al., 2022). Technical support provision can therefore reduce the perceived workload associated with technology usage, thereby acting to reduce the work-related burnout associated with this workload. I propose here that technical support provision may also be perceived by Irish university lecturers as a means of sharing the workload with another university employee, thereby reducing the individual lecturer's perceived overall workload. That the technical support provision was not shown to mitigate against the technostress creator-work performance relationship suggests that – while the technical support provision might prove beneficial in reduced work-related burnout, the level of this organisational assistance and support given to end-users of ICTs in Irish universities may not be sufficient in resolving technical problems that may arise, leading to a reduction in work performance, as demonstrated by participant narratives.

Participant narratives further suggest that the lack of other interactive effects involving technical support provision could be due to the lack of technical support with regards to emergency support needed when ICT equipment fails during meetings or lectures. This may increase the perceived complexity of the technologies being used in this situation, as there is a deficit of IT support to manage this complexity. The lack of an interactive effect of technical support provision and techno-invasion could be due to the likelihood that techno-invasion is largely associated with organisational and student expectations of out-of-hours lecturer availability, which is unlikely to be remediated through technical support provision.

The overall deficit of interactive effects between technostress creators and technostress inhibitors in this study suggests that university management efforts to promote digital literacy and involvement in the adoption of educational technologies have no effect on the work-related burnout experienced by university lecturers. This may be due to the extra workload imposed on university lecturers by such initiatives. Employers should facilitate employee workload allocation and management to allow for time in this workload to become familiar with, and to learn to use, new workplace technologies, by reducing other aspects of their workload during implementation of new workplace technologies (Jena, 2015; Rohwer et al., 2022). The lack of a mitigating effect of techno-facilitation initiatives could also be explained by some of the participant narratives, which suggest that there is often little training made available to lecturers when new technologies are introduced, and where such training is made available, it may be inadequate to meet the ICT upskilling needs of the lecturers. This is suggested in the following participant narrative: *"We just need more time and training on how to get the best use from new technologies The lack of training from my institution is shocking and people are thrown in at the deep end."*

This discussion demonstrates that the technostress mitigation measures currently being used in Irish universities are not sufficient in addressing the negative effects of reduced work performance or enhanced work-related burnout associated with most technostress creators. The management of the employer HEIs should invest in resources to identify the ICT-related needs of the lecturers as communicated by the lecturers, rather than imposed by academic management. Other technostress inhibitor mechanisms should also be explored with a view to reducing the negative impacts of technostress creators on university lecturers in academic work environments.

5.2.5 Research Question 5

"Is the Job Demands-Resources model adequate for describing the relationships between the variables named in Research Questions 4 and 5?"

All hypotheses and findings in this study contribute to addressing this research question. The essence of the application of the Job Demands-Resources model to this study is that technostress creators are positioned as job demands in academic workplaces, promoting work-related burnout along the health impairment pathway. The positive relationship demonstrated here between job demands and work-related burnout concurs with this burnout pathway of the Job Demands-Resources framework, thereby supporting the use of this framework in this research. Similarly, reduced work performance as a negative organisational outcome of this burnout pathway has also been proven in this study, lending further support for the suitability of this framework in this study. That the technostress creator–work performance pathway was not mediated by work-related burnout for all types of technostress creators does not indicate that this framework is not suited to the exploration of the relationships of these variables in academic work environments. Rather, I suggest that work-related burnout could only be one factor explaining some of this relationship and that the Job Demands-Resources Model would be useful in identifying the effects of other job characteristics that could potentially explain the negative relationship between technostress creators and reduced work performance. Similarly, I suggest here that the paucity of significant moderation effects of technostress inhibitors along both the technostress creator–work-related burnout and technostress creator–work performance pathway is not due to the failure of the model in explaining these relationships, but rather, the possibility that the model helps to highlight that the technostress mitigation measures that are being adopted to promote literacy and involvement facilitation, and technical support provision, are not adequately addressing the needs of university lecturers in mitigating against the negative effects of the technostress creators. These reasons are also likely fundamental to explaining the lack of a moderated mediation effect (*Hypothesis 10*) in explaining the relationship between these variables. It is proposed here that the Job Demands-Resources framework can be used to understand these reasons behind the lack of support for this moderated mediation model.

Exploration of these relationships within the Job Demands-Resources framework was supported by Russell et al.'s (2018) government-commissioned report, which advocated for the use of this model in investigating occupational stress in Ireland. The positioning of technostress creators as job demands within this framework, with work-related burnout an employee well-being outcome, and work performance as an organisational-level outcome of these technostress creators, framed a unique study into the investigation of the influences of technostress creators and technostress inhibitors in Irish higher education environments. These findings also support the use of the Job Demands-Resources Model in understanding the relationships between these outcomes and technology as a job demand in the university work environment. The use of this Job Demands-Resources model recognises the importance of considering both the individual and organisational factors associated with technostress in Irish university work environments. Consistent with Pffafinger et al.'s (2022) findings, the results here confirm that general occupational stress models can be applied to new forms of job demands, thereby extending existing empirical support for the effect of ICT demands on well-being.

5.3 Reducing technostress creators in university workplaces

The findings of this study have elicited the types of technostress likely to be experienced by Irish university lecturers, as well as some of the factors that may contribute to the creation of this technostress. This is consistent with Aktan and Toramen's (2022) recommendation that the negative situations that cause stress and burnout in educators should be identified, with policies and measures developed to eliminate these negative effects. This section therefore considers measures that may be considered by Irish university management in reducing the extent of technostress creators experienced by Irish university lecturers, while also reducing their negative effects through technostress inhibitors as organisational technostress mitigation measures.

The relationship between some technostress creators and work performance, as well as work-related burnout, has been confirmed. The impact of technostress inhibitors as organisational initiatives in reducing the relationships between technostress creators and work performance and work-related burnout, respectively, was investigated. However, few technostress inhibitors were shown to have a mitigating role to play in reducing the negative effects of technostress creators on work performance and work-related burnout, thereby suggesting that the technostress inhibitors need to be more specifically tailored to address the ICT-related needs of Irish university lecturers. Employee interaction with the technologies and expectations associated with the use of these in their work environment takes place within this organisational ecosystem. Berg-Beckhoff et al. (2017) recommend that "*The best way to prevent technostress is to secure the workplace organisational culture and provide support when implementing new technology*." (p. 169). Technostress experienced by individual employees potentially impacts on organisational performance, and the overall success of organisations. It is therefore imperative that organisational management implements measures to mitigate against the phenomenon of technostress (Ioannou et al., 2022). Organisational support is a key resource in addressing the negative outcomes, and promoting positive outcomes, of workplace technostress (Rohwer et al., 2022). Garraoi et al. (2022) suggests that it is important that HEIs identify the workplace characteristics and demands, and their influence on the role of the workers within HEIs, so that HEIs can develop and foster resources tailored to the specific needs of HEI workers.

Drawing from the findings arising from this study, this section of the discussion proposes an iterative methodology that can be applied in a university context when exploring the technostress experiences and effects, as well as mitigation measures, within a university environment. This broad framework (*Figure 5.1*) can be tailored to the specific needs of an individual university, as the organisational ecosystem for each university, as well as the job demands and resources within that university, are going to be unique. An iterative approach to identifying and managing technostress in Irish university environments on an ongoing basis is also essential due to the highly dynamic nature of the technological environment, meaning that the techno-stressors are likely to change as new technologies – and expectations associated with their use – are introduced. Technostress mitigation measures can therefore not be considered static, once-off interventions, but should instead be considered on an ongoing basis within Irish universities.

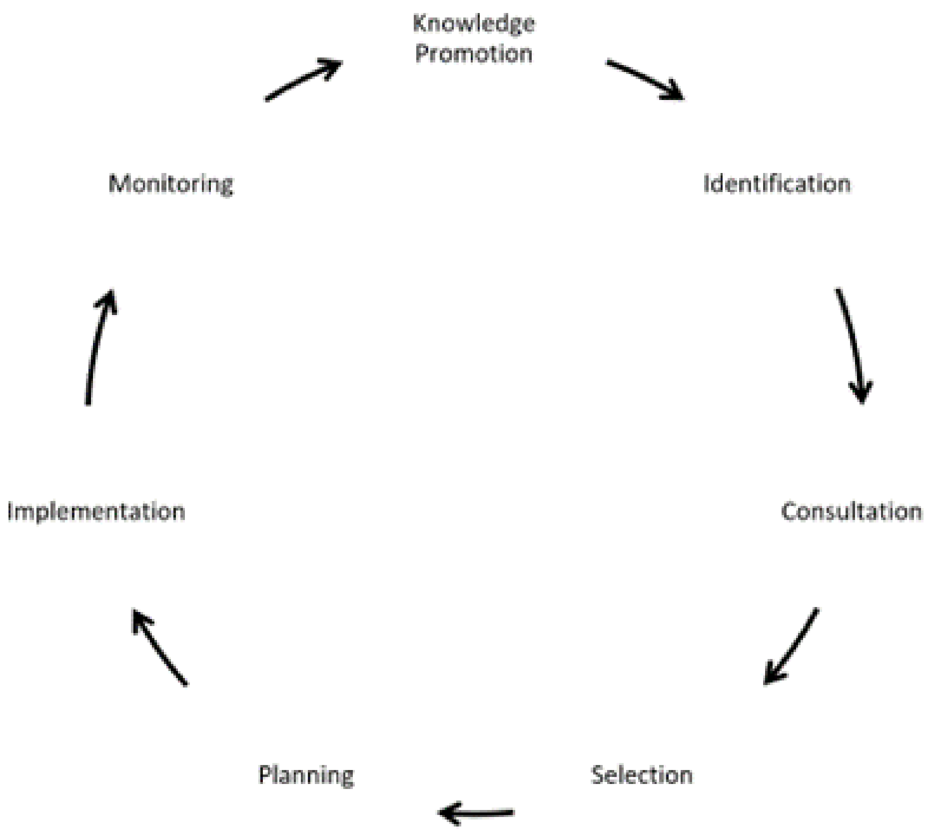

Figure 5.1 Managing technostress in university work environments

Knowledge promotion

This involves the promotion of understanding among university management about both the phenomenon of technostress, as well as its possible causes and contributors in academic work environments. This can be achieved through management workshops on the topic of technostress and its possible consequences, both in terms of individual employee well-being and organisational output. University lecturer experiences of technostress is not only a health issue for the individual lecturers, but also for university management (Zheng et al., 2022). Control of the factors causing technostress in occupational settings can minimise the negative effects of technostress, thereby helping HEI employees perform better at their jobs (Li & Wang, 2020). Academic managers have a duty-of-care towards their employees to ensure that workplace stress levels – of which technostress forms a significant component – are managed to ensure employee well-being, preventing burnout and also ensuring optimal functioning of the organisation as a whole.

Identification

Identification is two-fold. The type and extent of technostress creators present in the university should be identified. This can serve to highlight the areas where management intervention is needed to mitigate against the negative effects of technostress (Ragu-Nathan et al., 2008). University lecturing staff should be asked to identify possible interventions to facilitate a more comfortable and efficient usage of technologies in their work environments. This can also include an assessment of the efficacy of interventions, such as digital literacy training and technical support provision, that are already in place, and identification of areas where these may be further enhanced. This can be achieved through the use of surveys and focus groups. Surveys should include validated measurement scales related to technostress creators, inhibitors, work-related burnout and work performance. Fuglseth and Sørebø (2014) and Atanasoff and Venable (2017) recommend existing tools for measuring technostress to identify specific areas that should be considered. Consideration of the scores for individual survey items will elicit areas where further action to reduce technostress creators may be needed. Ragu-Nathan et al. (2008) suggested that their technostress creator and technostress inhibitor scales can be used to identify the absence and presence of technostress-causing factors. These could also include questions or statements unique to the working environment of a particular university, or division within a university, possibly incorporating questions about different types of technologies, expectations around their use, and supports needed. When considered within the Job Demands-Resources framework, these quantitative and qualitative data gathering methods are used to identify the technostress creators, as job demands, and technostress inhibitors, as job resources.

Consultation

Staff should be consulted about the organisational interventions proposed to mitigate against the negative effects of technostress creators. Involvement in these early decision-making processes will promote early familiarisation with new technologies, likely leading to reduced experience of technostress as a result of this early familiarity (Jena, 2015). Furthermore, mechanisms to facilitate the involvement of users should include encouraging staff to take risks and explore new ideas as part of learning about workplace ICTs (Tarafdar et al., 2011; Fuglseth & Sørebø, 2014). Education managers should include educators in the design and development of technologies used by educators. This inclusion should also extend to the development of policies and procedures regarding the use of these technologies in educational workplaces (Califf & Brooks, 2020).

Selection

This involves the selection of ICTs or technostress mitigation measures, securing of funding for these interventions. This should also consider the exploration of the usefulness and reliability of ICTs (Ayyagari et al., 2011). It is recognised that appropriately-designed managerial interventions can lead to the reduction of the impact of techno-stressors on ICT users (Day et al., 2012; Ragu-Nathan et al., 2008).

Planning

This involves the planning of the implementation of the technostress mitigation measures. The introduction of such measures should be considered at a personal and organisational level (Atanasoff & Venable, 2017). Planning should involve consideration of realistic timelines for the implementation of ICTs and/or technostress mitigation measures, to avoid the perception of technostress, particularly techno-overload and techno-complexity, arising out of the introduction of these. The introduction of new ICTs should also allow sufficient time for university lecturers to become familiar with the ICTs before having to use them for teaching, learning and assessment of students.

Implementation

This comprises the selective implementation of some of the proposed and agreed organisational interventions. The introduction of these interventions should be phased, so as not to overwhelm lecturing staff, thereby exacerbating technostress, particularly through techno-overload and techno-complexity. Delpechitre et al. (2019) recommends that managers should regulate the timing of technology improvements, to reduce role stress and enhance employee efforts to engage with, and use, new technologies. They further maintained that rapid changes to workplace technologies may have a negative impact on employee acceptance of the technology, as well as their work performance related to the use of the technology. This phasing-in of technological change also has the advantage of being able to monitor and evaluate the interventions introduced. This is particularly relevant, as techno-stressors can vary, depending on the types of technologies used (Califf & Brooks, 2020). The implementation of new technologies in universities should include the support of staff in establishing and maintaining workloads and work boundaries around ICT use (Atanasoff & Venable, 2017). Manager assignment of realistic workloads, the introduction of newer fitter-for-purpose technologies, establishing communication protocols and boundaries, while managing student expectations regarding lecturer availability and stress management interventions should also be considered during the implementation of new workplace technologies. These interventions can all be regarded as technostress inhibitors, acting as job resources to reduce organisational stress and work-related burnout, while also promoting university lecturer well-being and engagement within the Job Demands-Resources framework.

Monitoring

This encompasses both the monitoring of the technostress experiences of the lecturers, but also the long-term monitoring of the organisational interventions introduced to reduce technostress and promote well-being and productivity. This is consistent with Andrulli and Gerard’s (2023) recommendation that employee experiences of changes in their well-being in response to technostress perceptions should be recognised and remedied. Where deficits are noted, the cycle should be re-commenced. This will also help with monitoring any changes in university lecturer well-being in an increasingly blended and online higher education work environment due to persistent technological changes in educational delivery, assessment and administration.

While *Figure 5.1* gives an overview of how technostress mitigation measures can be identified, implemented and monitored within an academic work environment, *Table 5.1* summarises some specific measures that can be considered for implementation. These are drawn from the participant responses to the technostress inhibition questions in the survey, as well as their narrative contributions. Mitigation measures identified in the literature are also included.

Digital literacy facilitation   Design programmes for enhancing educator digital literacy to help workers deal with technological challenges (Tarafdar et al., 2015; Aktan & Toramen, 2022). Training should take place in advance of ICT changes being introduced (Atanasoff & Venable, 2017). The following measures should be considered: • Provision of training in the use of educational software. This should include consideration of training at an individual, or personal, level (Fuglseth and Sørebø, 2014). • Provision of training in pedagogies appropriate to support or facilitate a digital learning and assessment environment. • Establishment of a mentoring programme, whereby more digitally-experienced staff can mentor staff with lesser experience in using educational technologies (Aktan & Toramen, 2022). • Assist staff in the identification of digital skills training needs that need to be addressed to better manage workplace technologies (Atanasoff & Venable 2017). • Incorporation of time for the attainment and maintenance of digital literacy skills within the workload of the university lecturer, even if this means the reallocation of some of their assigned tasks (Fuglseth and Sørebø, 2014). • Encouragement of technological knowledge sharing between university lecturers (Fuglseth and Sørebø, 2014). • Organisation of user experience seminars to allow for exchange of ideas (Fuglseth and Sørebø, 2014).   ***Involvement facilitation***   • Involvement of university lecturers in decision-making about technological applications and their use for academic functions (Fuglseth and Sørebø, 2014). • Give university lecturers an internal stakeholder voice in the design of academic IT system requirements (Fuglseth and Sørebø, 2014). • Reward university lecturers for using new technologies (Fuglseth and Sørebø, 2014).

Technical support provision

- Ensure adequate IT service desk resources are in place to give timely responses when IT challenges arise for academic staff (Fuglseth and Sørebø, 2014). This should include a facility for an emergency response, whereby lecturing staff can avail of ICT assistance in the event of technology challenges during online meetings or teaching activities.
- Provision of adequate software and hardware for expected digitally-enhanced learning, teaching and assessment responsibilities.

Employee well-being

- University health and well-being programmes should be targeted at reducing the personal impact of technostress, with a view to helping lecturing staff develop coping strategies (Rohwer et al., 2022) in times of technological change and ever-increasing technological demands.

Promotion of a supportive organisational culture and expectations

Addressing organisational culture and expectations associated with technology use can alleviate technostress experiences (Atanasoff & Venable, 2017)

- Introduction of staff availability policies (e.g., Rohwer et al., 2022) to support staff in setting boundaries between their work and non-work lives. Management should be encouraged to support of staff in adhering to these policies.
- Facilitation of staff workshops on time management (e.g., Rasool et al., 2022).

Other practical measures

- Facilitating university lecturers in overall workload management, by setting communication boundaries, supporting them in blocking off their time for periods during the week to concentrate on their work without expectations of being immediately contactable and responsive via email, mobile phone, video calls, social media. Mediation should be made available to university lecturers where workload management negotiations are required.
- Individual interventions should also be made available to staff struggling to deal with the adverse consequences of technostress (Atanasoff & Venable, 2017).
- Lecturing staff should be encouraged to identify individual triggers of technostress, e.g. checking of work emails late at night, leading to sleep disruption (Atanasoff & Venable, 2017).
- Lecturing staff should be referred to psychological support in the event of technostress resulting in maladaptive behaviours, such as alcoholism (Atanasoff & Venable, 2017).

Table 5.1 Recommended technostress creator mitigation measures in higher education workplaces

Despite technological disruption, work-intensification, increased academic workloads, and negative consequences at both an individual and organisational level due to the rapid digital transformation of higher education workplaces, there is an expectation that university staff are responsible for the maintenance of their own well-being (Harunavamwe & Ward, 2022). The measures outlined above present the organisational interventions that can be adopted to mitigate against the ICT-related job demands that may significantly contribute to the erosion of academic worker well-being over time. It is imperative that university management acknowledge the role that organisational factors have to play in overall university lecturer well-being, recognising that manifestations of technostress at the level of the individual worker are in response to their work environment, including the job demands and job resources defining that environment, as is recognised by the Job Demands-Resources model of occupational stress.

5.4 Contributions to the literature

The exploration and findings described here of technostress experiences of Irish university lecturers using digital technologies for educational purposes addressed a need identified in the literature to explore technostress creators in defined occupational contexts (e.g., Jena, 2015; Boyer-Davis et al., 2020; Borle et al., 2021; Li & Wang, 2021). The results of this exploratory study confirm some of the findings of prior research as published in the literature, while also providing some novel insights into the relationships between the study variables. The main contributions summarised here arise out of the results of quantitative analyses of survey data, thematic analyses of participant narrative contributions, as well as insights associated with these findings. This exploratory study of technostress within the occupational context of higher education contributes to the growing body of knowledge regarding the phenomenon of technostress, and its individual and organisational consequences in higher education work environments. The ways in which this study has contributed to this growing body of knowledge are outlined here.

The first main contribution is that survey data confirmed the presence of technostress in Irish university lecturers. This contribution is important for two reasons. Firstly, quantitative analyses of survey findings highlights the main types of technostress creator associated with working as a higher education lecturer. The second contribution regarding technostress creators is the identification of some of the specific work environment and organisational features that are likely to drive the experience of these technostress creators.

The second main contribution is the finding that workplace technostress inhibitors, as measured by the Technostress Inhibitor Scale, may not have the desired effect of reducing the negative personal and organisational consequences of technostress creators in higher education work environments. I suggest that the findings of this study highlights the need to reconsider the identification, and role of, technostress inhibitors as job resources in mitigating against the negative individual and organisational effects of technostress creators as job demands in higher education work contexts. The findings of this study have contributed to the relative paucity of research into the intended effects of technostress inhibitors as job resources intended to reduce the negative effects of ICT as a workplace job demand. The results here suggest that organisational characteristics intended to mitigate against negative technostress creator outcomes do not seem to have the effect intended. I propose that the type, implementation and effectiveness of such technostress inhibitors therefore needs to be revisited, particularly with reference to higher education work environments. I also recommend that the types of technostress inhibitors – as conceptualised by the technostress inhibitor scale – be revised with the view to capturing a more detailed analysis of the factors that may further facilitate the intended mitigation effects of technostress inhibitors.

The participant narrative findings here suggest that there are digital literacy initiatives that should be explored as potential technostress inhibitors, in additional to formal ICT training programmes. These include: digital induction for new and returning lecturing staff; peer-to-peer learning; mentoring. Participant narratives also suggest that greater involvement of lecturing staff in selection and decision-making regarding software that is fit-for-purpose is required as part of the involvement facilitation technostress inhibitor construct. In terms of technical support provision, the need for 'emergency' support was highlighted, to help trouble-shooting particularly in time-critical situations, such as online meetings. As communication challenges around ICT introduction into higher education workplaces was a common theme in the participant narratives, an additional contribution of this research is the identification of an effective ICT-related communication strategy as a possible technostress inhibitor in helping to keep staff informed of ICT developments within the HEI, as well as expectations around its use. This should form part of an HEI's change management initiatives around the introduction of ICT systems.

A further contribution of this study with regards to technostress inhibitors is the need for Irish HEI management to follow a planned introduction and implementation of new ICTs into higher education work settings. The technostress inhibitors as proposed in the literature and suggested by the participant narratives formed the basis of the framework proposed in *Figure 5.1* for managing technostress in university environments, with this framework also providing a unique contribution to the literature. It is intended to guide academic management in how to introduce technostress inhibitors into a higher education workplace, through collaborative decision-making with lecturing staff concerning the selection, implementation and evaluation of ICT initiatives in an iterative manner. This contributes to the growing body of literature on technostress mitigation measures in the workplace, as suggested by Rohwer et al. (2022).

The final main contribution of this exploratory study is that the findings support the value of the application of the Job Demands-Resources Theory as a tool in the study of occupational stress in higher education work environments. The validity of use of the health impairment pathway of the Job Demands-Resources framework in studying ICT as an occupational stressor and job demand in the occupational context of Irish academia is supported by these findings. The findings of this study align with the health impairment pathway of the Job Demands-Resources framework, demonstrating that workplace technostress creators can impair lecturer well-being in the form of work-related burnout, while also negatively influencing work performance, as an organisational outcome. This is a unique contribution to the literature, as this has not yet before been investigated or demonstrated in the published domain for a sample of Irish university lecturers. The flexibility of this model allows for the positioning of workplace ICT as either a job demand or a job resources within an academic work environment. The lack of expected interaction effects between the technostress creators and technostress inhibitors in this exploratory studet suggests that further exploration of ICT as a job resources within HE work environments is warranted.

While specific consideration was given here to the relationships between technostress creators, work-related burnout, work performance and technostress inhibitors within the context of the broader Irish university system, both the findings and practical implications and suggestions can be used to inform research and technostress interventions in other occupational contexts.

5.5 Study limitations

This section explores the following limitations to the research described here: literature search; cross-sectional, survey-based methodology; convenience and snowball sampling; survey fatigue and heavy workloads; sample size; data collection challenges; aggregate of technologies; emergency remote teaching due to Covid-19 lockdowns; individual differences.

Literature search: Despite the quality of the articles provided by the search engines used, the articles selected for inclusion in the review may be prone to subjective bias (Zheng et al., 2022) in their selection. While the literature review undertaken was comprehensive, it did not strictly follow the methodology of a systematic literature review, so may not have captured all published literature in this domain. The use of the term "technostress" has only gained traction in the literature in recent years. Use of this term as a literature search term may therefore be less effective at identifying and retrieving older studies in the domain of workplace ICT-related negative individual psychological and organisational outcomes (Borle et al., 2021).

Aggregate of technologies: This study included reference to educational technologies as an aggregate concept, collectively referring to all technologies being used in educational contexts. Califf and Brooks (2020) suggest that educator perceptions of techno-stressors could vary, depending on the types of technologies used. The study described here was limited in that it does not examine the contributions of specific technologies to technostress.

Convenience and snowball sampling: The use of these sampling methods for data collection is reliant on participant self-selection. This may result in sampling bias, whereby those interested in, or who feel affected by, technostress may be more likely to engage with the survey than other potential participants. The use of these sampling approaches may therefore limit the generalisation of the results (Wang & Zhao, 2023). The use of this sampling methodology also suggests that the findings of this study cannot be deemed to be representative of the overall population of university lecturers (Ioannou et al., 2022). Although the participant sample was not selected within a single university context, the context for this study was the broader Irish higher education sector. Although it could be argued that not all lecturer experiences with workplace ICTs are the same in all universities, the emphasis in this study was on the relationship between the experiences of technostress creators and their impact on individual university lecturer burnout and work performance.

Cross-sectional, survey-based methodology: There are a number of limitations to this methodology, despite its wide application in organisational research (e.g., Spector, 2019). Firstly, this methodology relies on participant self-report responses, which can lead to biased responses, such as common method bias (Andrulli & Gerards, 2023). However, statistical testing for common method bias here (Section 3.8.3) showed that this was not present in this study. A second limitation is that the data generated from cross-sectional designs is presented in an aggregate manner (Cohen et al,. 2018), which does not allow for in-depth investigation of findings. However, the use of participant narrative data in this study as an additional source of information in support of the survey findings, served to strengthen the robustness of the findings of this exploratory study, while allowing for greater insights into some of the results of the quantitative analyses. A third limitation of this methodology is that it provides a ”snapshot” of findings (Cohen et al., 2018). As data was gathered only once from participants in this study, this methodology did not facilitate the capturing of respondents’ long-term views, attitudes and beliefs associated with technologies in higher education, and the consequences of such. This is particularly relevant to the experiences of burnout, as work-related burnout typically arises out of the exposure to prolonged, chronic work-related stressors over a period of time (e.g., Berg-Beckhoff et al., 2017). Despite this type of methodology being used in the measurement of burnout in previous studies (e.g., Kristensen et al., 2005; Milfont et al., 2008; Singh & Singh, 2018), it could be argued that a methodology that instead encompasses data gathering over a longer duration would be more suited to studies of burnout. As it was exploratory in nature, the data gathered through this cross-sectional survey study can contribute to the formulation of more in-depth studies of the ICT-related job demand stressors and job resources within higher education work environments.

Sample size: A small sample such as the one used here may restrict the testing of more complexity models exploring relationships between variables, and promotion of understanding of these variables (Garraoi et al., 2022).

Data collection in a single country: The data for this study was collected only within the Republic of Ireland. While the advantages of this approach are that the findings are relevant to the higher education environment in this country, it could also be argued that the findings cannot be generalised to other countries. However, Califf and Brooks (2020) suggest that such findings should be generalisable to other countries on the basis that many of the educational technologies that educators engage with are used within the international education system and are therefore not specific to one particular country.

Data collection timing: The data was collected at the end of the Semester 1 of the academic year. This is a time when lecturers may be experiencing high workloads, possibly reducing the time available to them to respond to surveys for research purposes. The importance of timing of data collection when undertaking research in higher education contexts has also been recognised by Garraoi et al. (2022).

Survey fatigue: Survey fatigue may also mitigate against survey participation. Potential participants already experiencing techno-overload, or experiencing distress associated with having to use workplace technologies, might find being invited to participate in an online survey a discomforting attempt at adding to their experience of techno-overload.

Influence of Covid-19 emergency remote teaching: Exploring lecturer experiences of emergency remote teaching associated with Covid-19 lockdowns was not the primary aim of this research. It is however recognised that the relative recency of these experiences may have influenced participant responses in this research. It is recognised in the literature (e.g., Aktan & Toraman, 2022; Garraio et al., 2022; Zheng et al., 2022) that the pivot to emergency online educational delivery was incredibly stressful for university lecturers. It is possible that the negative experiences associated with both this pivot, accompanied by the fear of the pandemic and associated illness, could have contributed towards negative perceptions of educational technologies by some participants, particularly with the persistence of their use in the post-lockdown educational context.

Individual differences: This study did not include the exploration of personality traits and individual differences (e.g., Srivastava et al., 2015; Krishnan, 2017; Ioannou et al., 2022; Saidy et al., 2022) in the development of technostress.

5.6 Further research

The study as reported here was undertaken with the intention of being an exploratory study to elicit the existence of technostress within a sample of Irish university lecturers, as well as to probe the relationship of these technostress creators to work-related burnout, work performance and technostress inhibitors. The findings of this study suggest that there are areas of further research required into technostress in Irish university workplaces. This is in keeping with the recognition of a need for further research in technostress in other occupational domains (e.g., Saidy et al., 2022), as well as the exploration of the relationship between workplace technologies and employee health and well-being (Yener et al., 2021). Some specific areas of research have been identified arising out of the study described here.

Demographic variables: While the role of demographic variables of age, gender and education level and their relationship to technostress were explored here, there is scope to explore other demographic variables and their relationship to technostress (Wang & Zhao, 2023). Relevant variables to the contemporary higher education context in Ireland include socioeconomic status due to the cost-of-living and accommodation crises in the Republic of Ireland at the time of writing this thesis, meaning that some academic staff may be classed among the 'working poor'. The effects of commuting, hybrid and work-from-home arrangements on the relationships explored here should also be considered, given the changed nature of work, including in HEIs, as it has been recognised (e.g., Berg-Beckhoff et al., 2017) that ICT usage may reduce stress by opening up new ways to structure work, such as increased remote working.

Technostress mitigation measures: The lack of technostress inhibitor mitigation of the negative effects of technostress creators in Irish university work environments as found in this study suggests that there is a need for the adaptation of current mitigation measures, and the identification of other mitigation measures that may be more effective in reducing this technostress experience for Irish university lecturers. Technostress inhibitors to mitigate against the negative effects of technostress should be further explored at an organisational level. For example, with reference to organisational culture and job design and their influence on technostress. This recommendation is in keeping with Ioannou et al.s' (2022) conclusion that there is currently a paucity of research exploring the means that could be used to alleviate the adverse after-effects of technostress.

Longitudinal studies: Longitudinal studies of lecturer experiences of technostress and the impact this has on them and their employer university would be more informative, particularly due to the nature of the academic workload likely to vary over course of the academic year, with some times of year, e.g. during the teaching part of a semester, placing different workplace demands on university lecturers, relative to other times of the academic year, e.g. examination periods. Longitudinal studies are more likely to inform understanding of how stressors, and the individual's response to these, may change over time, which is also associated with the duration of exposure to ICT-related stressors. Repeated measures of the constructs measured here, over a period of time, would allow for a much more detailed analysis of the influence of technostress on university lecturer well-being and work performance. Califf and Brooks (2020), Gabr et al., (2021) and Andrulli and Gerards (2023) also promote the future use of longitudinal studies to explore the relationship between technostress and employee well-being. However, the timeframes required for such longitudinal studies would have been incompatible with the timelines of this study.

Qualitative studies: Future research should include a more rigorous mixed-methods approach to allow for a more in-depth exploration of the technostress creator and inhibitors experiences of lecturers. The participant narratives recorded at the end of the survey used in this study indicated how data-rich qualitative data could be in promoting the explanation and understanding of the organisational factors influencing the employee experiences of technostress creators and their outcomes.

Control and autonomy: The technostress creators measured in this study recognised work overload, invasion of non-work time, complexity of technology, uncertainty and insecurity of work-related ICT use. However, the participant narratives suggested that the perceived lack of control and autonomy related to both the adoption and implementation of new workplace ICTs, should also be considered as technostress creators. The lack of control or autonomy over both the pace of introduction of ICTs and the task-specific use of these can also cause ICT-related stress (Atanasoff & Venable, 2007; Berg-Beckhoff et al., 2017). This may be a particular consideration in higher education work environments, where university lecturing staff are used to relatively high levels of autonomy, which they may feel is being encroached upon by management's expectations of ICT use. However, further exploration of lecturer motivation within the self-determination theory framework was beyond the scope of this study. This emphasises the importance of job design in whether an individual may (or may not) experience the negative effects of excess technostress.

Other outcomes: Although this study emphasised work-related burnout and work performance as effects of technostress creators, future technostress research on the effects of technostress in academic work environments, such as organisational commitment (Ioannou et al., 2022) and turnover intentions (Califf & Brooks, 2020; Ioannou et al., 2022), should also be studied. The necessity of inclusion of these outcomes was highlighted by the response from a study participant who suggested that the reliance on ICT in their educational workplace impaired their sense of workplace belonging to the extent that they moved to a non-lecturing position within their university.

ICT communications: Communication as a potential techno-stressor has been mentioned in the literature (e.g. Atanasoff & Venable, 2017), but has not been explored to date in academic work environments. The use of ICT as a work-place communication tool contributes to techno-invasion as a technostress creator. Techno-invasion was shown to have a significant relationship with both increased burnout and reduced work performance in this study. Even though the role of communication as a technostress creator was not specifically explored in relation to technostress in this study, participant narratives highlighted the benefits of ICT-facilitated communications, but also noted the role of ICT-facilitated communication in promoting technostress, particularly, techno-invasion. The role of workplace technologies in communication overload was also highlighted by the participant narratives. This should include consideration of the social overload associated with expectations to frequently access social networking apps for work purposes. It is proposed here that a more detailed analysis of the nature and effects of ICT-facilitated inter-collegial communication in academic work environments should be further investigated. As communication is a key resource regarding the mitigation of technostress (Rohwer et al., 2022), the findings of such a study could be used to inform university communication and staff engagement and motivation strategies.

Techno-eustress: Most technostress research to date has emphasised the negative effects of technostress creators, termed the “dark side” of technostress (e.g., Tarafdar et al., 2013; Delpechitre et al., 2019; Rohwer et al., 2022), due to their tendency to harm both individual employees and their employer organisations (Califf et al., 2020). However, some literature (e.g., Berg-Beckhoff et al., 2017; Tarafdar et al., 2017) recognises that technology, as a workplace stressor, may be appraised positively by the individual, creating a state of eustress instead of distress. Future research should address the dearth of studies into the development and maintenance of techno-eustress, with consideration of the Yerkes-Dodson Law (Karr-Wisniewski & Lu, 2010; Hung et al., 2015).

Non-linear relationships: The analyses undertaken in this study assumed linear relationships between predictor and outcome variables. The Yerkes-Dodson Law suggests that relationships between workplace stressors, such as technostress creators, and work performance is not linear. Future studies of the relationship between variables studied here should consider the Yerkes-Dodson law, with a view to optimising lecturer well-being and work performance when using technology. This exploration of a U-shaped relationship between technostress creators and outcomes was also proposed by Chandra et al. (2019) and Rohwer et al. (2022). When considered within the Job Demands-Resources framework, this implies that further investigation is needed into the conditions under which workplace technologies cease to be job resources, and instead become job demands with negative consequences (Delpechitre et al., 2019).

Large language models: The recent widespread availability of large language artificial intelligence models, such as Chat GPT, have accelerated technological disruption of higher education (e.g., Arif et al., 2023; Tlili et al., 2023). Future research in the domain of technostress in higher education settings should explore whether such AI applications are job resources, promoting engagement, or job demands, promoting health impairment, within the context of the Job Demands-Resources model.

Chapter 6: Conclusion

The exploratory study as described here aimed to promote understanding of academic work environment job characteristics that may lead to, or reduce, technostress and its individual and organisational consequences. The findings show that technostress is experienced by academic staff in response to ICT-enabled work overload, leading to invasion of personal, non-work time, the experience of complexity of technology systems and – to a limited extent – insecurity, arising out of the use of academic workplace technologies. These findings further show that this may lead to negative individual consequences, in the form of work-related burnout experienced by university lecturers, possibly resulting in unintended organisational consequences of reduced work performance associated with technostress. Unexpectedly, participants did not experience much reduction in these negative consequences arising out of organisational technostress mitigation measures, such as literacy support, the development of digital literacy skills and the provision of technical support. When viewing the findings through this interpretive lens, I therefore conclude that the technostress inhibitors currently utilised by Irish universities are not sufficient to mitigate against the levels of technostress being experienced by Irish university lecturing staff.

These findings lend support for further investigation into the technostress experiences of Irish university lecturers, emphasising both the benefits and challenges associated with technological reliance in the Irish higher education sector. There is also a need to identify and explore effective technostress mitigation measure to foster a healthier and more productive work environment in today's digitally-dominated Irish higher education landscape. The findings of this study further highlight the importance of recognising that technostress arises out of the interaction between the individual worker and their work environment. The characteristics of both the individual lecturer and their work environment must therefore be considered when planning and implementing technostress mitigation measures. The findings of this study can be used by decision-makers in higher education settings to identify the specific stressors associated with technology adoption in higher education to meet their duty-of-care to their academic employees, including evaluation of work-related risks and prevention of negative consequences of stress. This may extend to job redesign, more proactive management of university lecturer workloads, increased resources to help academic staff effectively manage their workloads, while also supporting academic staff in setting work boundaries to ensure sufficient periods of rest and relaxation. This study supports the use of the Job Demands-Resources model as an effective tool in exploring the impact of such interventions on both the individual academic worker, and their employer university. The use of this model is further encouraged due to the flexibility that it affords in examining a variety of organisational and job characteristics and their influence in university lecturers. This facilitates the ongoing monitoring and re-design of work responsibilities, resources and supports.

In conclusion, this study has identified the existence of technostress in a sample of Irish university lecturers, suggesting a need for academic staff to be supported in the safe and effective utilisation of educational technologies, while also ensuring optimisation of their well-being, and promotion of their work performance.

Chapter 7: References

(In accordance with the Lancaster University Library APA 7th Referencing Guide)

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Chapter 8: Appendix – Participant Survey

The content below is available as an MS Forms survey at the link here: https://forms.office.com/r/vD8C5pfTcM

Technostress in University Lecturers

Participant Information

Dear Research Participant,

I am inviting you to participate in a study on Technostress in University Lecturers. The purpose of this study is to generate information about the impact of work-related technology use on Irish university lecturers. The findings of this research will contribute towards a better understanding of the factors influencing technological engagement by Irish higher education staff. This study is being carried out in accordance with the regulations of the TU Dublin Research Ethics and Integrity Committee. The data generated will also be analysed and presented as part of Dr. Linda Moore's PhD in Higher Education: Research, Evaluation and Enhancement, being undertaken at Lancaster University, as approved by the Faculty of Arts and Social Sciences and Lancaster University Management School Joint Research Ethics Committee.

All survey data will be kept anonymous and strictly confidential. Data from this study will be stored and analysed using TU Dublin-licensed and secured software. Your survey data will be used solely for academic research within TU Dublin and Lancaster University, as per the EU's recognition of the UK as a third country for the sharing of data. There is no identifying information requested from you in the survey, meaning your information (your name and employer university) cannot be identified in the presentation and dissemination of findings. Upon completion of this study, this anonymous data will be lodged in a FAIR research repository to support accessibility of data in accordance with TU Dublin guidelines and requirements.

Your participation in this study is voluntary. You are free to stop your participation in the survey at any time if you do not wish to continue. Your completion of this online survey implies your consent to provide your data for our research only for the purpose described above. As the data is being collected anonymously, there is no way of identifying individual responses and it is therefore not possible to remove individual participant data after your responses have been submitted. If at any time you have a question about your rights or options as a research participant, please contact Linda Moore, the principal investigator, at Linda.Moore@tudublin.ie.

This survey will take you approximately 5-10 minutes to complete. Your participation is valuable and greatly appreciated. The closing date of the survey is 28th February 2023.

If this is likely to be an uncomfortably emotive subject for you, you are advised not to take part in this survey. If you would like to participate, then please proceed to confirm your consent by answering the questions that follow, then proceed to undertake the survey.

Please note that the term 'technology' used throughout this survey refers to the day- to-day computer-based applications you use in your job while undertaking education-related tasks related to lecturing, research and administration. This includes, but is not limited to, e-mail, learning management software, academic administration systems, and other workplace technologies that you use in undertaking your work functions.

Kind Regards,

Dr Linda Moore (Principal Researcher)

Participant Consent

The following background information will help me understand your survey responses.

1. Please select the category that is most closely aligned with your age.

Less than 25 years	
26-35 years	
36-45 years	
46-55 years	
56-65 years	
Older than 65 years	

2. Please select the term that best refers to your gender.

Female	
Male	
Non-binary	
Prefer not to say	

3. Please indicate the highest level of education that you have achieved.

Leaving Certificate (or equivalent)	
Ordinary degree	
Honours degree	
Post-graduate diploma	
Master’s 3degree	
PhD	
Other	

4. Please insert the total number of years that you have worked as a lecturer in a higher education institution (Institute of Technology and/or university) in either a part-time or full-time capacity.

5. Please rate your confidence in using the digital technologies associated with your work responsibilities (where 1 star = extremely low confidence and 10 stars = extremely high confidence).

6. Please indicate the extent to which you disagree or agree with each of the statements below.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I am forced by technology to work much faster					
I am forced by technology to do more work than I can handle					
I am forced by technology to work with very tight time schedules					
I am forced to change my work habits to adapt to new technologies					
I have a higher workload because of increased technology complexity					
I spend less time with my family due to work-related technology					
I have to be in touch with my work even during my holidays due to work- related technology					
I have to sacrifice my holiday and weekend time to keep current on new work- related technologies					
I feel my personal life is being invaded by work-related technology					
I do not know enough about the work-related technology to handle my job satisfactorily					
I need a long time to understand and use new work-related technologies					
I do not find enough time to study and upgrade my work-related technology skills					

I find new recruits to my university know more about computer technology than I do					
I often find it too complex for me to understand and use new work-related technologies					
I have to constantly update my technological skills to avoid being replaced at work					
I feel threatened by co-workers with newer technology skills					
I do not share my technology knowledge with my co- workers for fear of being replaced					
I feel there is less sharing of technology knowledge among co-workers for fear of being replaced					

7. Please indicate the extent to which you disagree or agree with each of the statements below.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
There are always new development s in the technologies we use in our organization					
There are constant changes in computer software in my employer university					
There are constant changes in computer hardware in my employer university					
My employer university encourages knowledge sharing to help deal with new technology					
My employer university provides training when					

new work- related technologies are introduced					
Our IT help desk is easily accessible					
Our IT help desk is responsive to staff requests					
Academic staff are encouraged to try out new technologies					
Academic staff are rewarded for using new technologies					
Academic staff are involved in work-related technology introduction, change and/or implementation					

8. Please indicate the extent to which you experience the following:

	Never	Seldom	Sometimes	Often	Always
I feel worn out at the end of the working day					
I am exhausted in the morning at the thought of another day at work					
I have enough energy for family and friends during leisure time					

9. Please indicate the extent to which you experience the following:

	To a very low degree	To a low degree	Somewhat	To a high degree	To a very high degree
My work is emotionally exhausting					
My work frustrates me					
I have enough energy for family and friends during leisure time					

10. Please indicate the extent to which you disagree or agree with each of the statements below.

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Technology helps to improve the quality of my work					
Technology helps to improve my productivity associated with work					
Technology allows me to accomplish more work than would otherwise be possible					
Technology helps me to perform my job better					

Please answer the following questions regarding your use of computing technologies for teaching, learning and assessment purposes.

11. Please describe what you perceive as the benefits (for the lecturer) of using digital technologies in a higher education workplace.

12. Please describe what you perceive at the disadvantages (for the lecturer) of using digital technologies in a higher education workplace.

13. Please share any other thoughts you have concerning the use of digital technologies in your workplace and the impact that they may have on you and how you approach your work.