



Investigating the impact of technostress on productivity and overall life satisfaction of managers working at a South African ferrochrome smelting company



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Orientation: Information and Communication Technology (ICT) advances such as computers, tablets, and cell phones allow for information flow like never before, both in terms of speed and volume. But, unfortunately, this has resulted in technostress.

Research purpose: To investigate the impact of technostress on the productivity and the overall life satisfaction of managers working in ferrochrome smelters.

Motivation for the study: Limited research has been conducted on technostress in a South African context. Most of the researches on technostress were conducted amongst computer professionals and Information Technology (IT) consultants and they did not focus on non-ICT specialists such as managers who are exposed to ICT as a regular part of their workday.

Research approach/design and method: This study was conducted within a quantitative paradigm using a correlational design.

Main findings: The managers experience low levels of technostress, high levels of IT-enabled productivity, and above-average life satisfaction. No practically significant differences exist for any of the research factors between males and females, whilst techno-complexity and techno-uncertainty increase with age. Technostress does not affect productivity, but a negative relationship exists between technostress and life satisfaction.

Practical/managerial implications: Techno-uncertainty and techno-complexity are present amongst older managerial employees. Techno-complexity decreases the self-reported levels of productivity. Strategies such as training and assistance to reduce the techno-complexity for older managerial employees should be considered.

Contribution/value-add: This study creates an awareness of the potential negative impact of ICT on productivity and life satisfaction. It contributes to the body of knowledge by quantifying the impact of the managers' perceived technostress on productivity and life satisfaction.

Keywords: ferrochrome smelter; life satisfaction; managers; productivity; techno-complexity; techno-insecurity; techno-invasion; techno-overload; techno-stressors; techno-uncertainty.

Introduction

This article reports on the impact of technostress on the productivity and life satisfaction of managers at a South African ferrochrome smelting company. There is contradictory evidence regarding the effect of technostress on productivity. For example, Pirkkalainen, Salo, Tarafdar and Makonnen (2019) found that increased technostress leads to decreased productivity, whereas Lee, Lee and Suh (2016) found that higher techno strain levels increased the productivity. According to Kazekami (2020) and Lee et al. (2016), increased technostress decreases the overall life satisfaction. Most research has been conducted on employees exposed continuously to Information and Communication Technology (ICT) as a regular part of their workdays, such as computer professionals (Van Eck, 2005) and IT consultants (Ferziani, Rajagukguk, & Analya, 2018). The problem with this approach is that ICT has advanced to such an extent that it is filtering through and becoming an integral part of most business functions and, as a result, potentially affects employees who do not specialise in Information Technology (IT). Technological advancements over the past few decades have had a pronounced effect on how companies do business. These advancements have affected nearly all aspects of the working life (Sowell, 1995). When laptops, cellular phones, internet and video conferencing started emerging in the 1990s, people reacted negatively towards technology (Hess, 2004). These adverse effects on attitudes, thoughts, and behaviour, either directly or indirectly through the use of technology, result from

what was termed 'technostress' (Weil & Rosen, 1997). The literature has shown that increased levels of technostress can lead to a reduction in productivity (Pirkkalainen et al., 2019) and overall life satisfaction (Lee et al., 2016). Because the list of new technologies is growing daily (West, 2019), the research topic of technostress and its possible adverse effects on productivity and overall life satisfaction remains current and relevant. Besides the potential effects on productivity and overall life satisfaction, various international organisations such as the International Labour Organization and the World Health Organization have also voiced their concerns about the potential adverse effects of technostress on employee health (Mahboob & Khan, 2016).

According to Van Eck (2005), limited research has been conducted on technostress in a South African context. Bonnah (2015) makes a similar comment as it pertains to sub-Saharan Africa. Most research has been conducted on employees who are constantly exposed to ICTs as a regular part of their workdays, such as computer professionals (Van Eck, 2005) and IT consultants (Ferziani et al., 2018). The problem with this approach is that ICTs proliferate throughout organisations, thereby affecting people who are not ICT specialists. Therefore, this research focused on non-ICT specialists (i.e. managers), who are also exposed to ICT as a regular part of their workday. This study fills these gaps by investigating the impact of managers' technostress on productivity and life satisfaction.

The purpose of this study was to determine the degree to which non-ICT managers working at a ferrochrome smelting company experience technostress and its effect on their productivity and overall life satisfaction. The objectives of this research were to establish the technostress, productivity and life satisfaction levels of managerial employees; to determine whether there are practically significant differences in the mean scores of technostress, productivity and life satisfaction between gender and age groups, and establish whether there is a correlation between technostress, productivity and life satisfaction. Based on the objectives, the following research questions were formulated: What are the levels of technostress, productivity, and life satisfaction of managerial employees? Are there practically significant differences in the mean scores of technostress, productivity, and life satisfaction between gender and age groups? Is there a correlation between technostress, productivity and life satisfaction?

Literature review

Technostress is defined as a modern disease of adaptation caused by the inability to cope with new computer technologies (Brod 1984, p. 16). Technostress comprises five dimensions which are referred to as technostressors: techno-overload, techno-invasion, techno-complexity, techno-insecurity, and techno uncertainty (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). According to Tarafdar et al. (2011, p. 119) and Ragu-Nathan et al. (2008), Nimrod (2018), techno-overload occurs when ICTs force employees to work harder.

Techno-invasion is the penetration of ICTs into employees' personal lives. Techno-complexity occurs when ICTs create a sense of incompetence amongst employees. It involves situations in which the complexity of technology makes users feel inadequate about their technology skills, resulting in them spending more time and effort to understand the technology. Techno-insecurity refers to stressful situations that make users feel threatened about losing their jobs to more proficient people using ICT. Techno-uncertainty arises when the pace at which software, hardware, and computer networks change.

According to TechTarget (2021), IT productivity refers 'to the relationship between an organisation's technology investments and its corresponding efficiency gains, or return on investment'. Tarafdar, Tu and Ragu-Nathan (2010) investigated the impact of technostress on end-user satisfaction and performance. They utilised the Transactional Model of Stress and Coping (TMSC) as their theoretical-conceptual framework. Hence, they made use of techno-stressors to measure the degree to which employees experience technostress. To measure technostress, they adopted a measuring instrument from Tarafdar, Tu and Ragu-Nathan (2007). To measure productivity, they adopted a measuring instrument from Torzadeh and Doll (1989). The research involved 233 ICT users. The techno-stressors' average mean scores were techno-overload 2.97, techno-invasion 1.91, techno-complexity 2.54, techno-insecurity 2.00 and techno-uncertainty 3.15. In summary, techno-overload and techno-uncertainty stressors contributed the most to feelings of technostress, whereas the remaining three techno-stressors had little to no effect. Techno-invasion and techno-insecurity were scored below average, indicating that these stressors did not contribute to the perception of technostress. The average mean score obtained for productivity was 3.8.

Pirkkalainen et al. (2019) researched the effect of coping behaviours on the levels of technostress experienced and the effect thereof on productivity. Their sample comprised 846 organisational IT users from the United States of America. They used the same measuring instrument as Chen (2015), except for techno-uncertainty, which they omitted. This measuring instrument is based on the TMSC and uses the same five techno-stressors discussed earlier, measured using a five-point Likert scale. The average for techno-overload was 2.94, for techno-invasion 2.54, for techno-complexity 2.51 and techno-insecurity 2.34 (Pirkkalainen et al., 2019). The measuring instrument used for productivity was the same as that used by Tarafdar et al. (2007). A five-point Likert scale was used to measure IT-enabled productivity. The average mean score was 4.06. To summarise the results, the participants experienced only moderate levels of techno-overload. They were neutral concerning the effects of techno-invasion and techno-complexity. The average for techno-insecurity shows that this was not a genuine concern for the respondents. However, they reported high levels of IT-enabled productivity. Both the studies listed above used the same measuring instruments to measure technostress and productivity, making it ideal for comparison. Both the

studies were conducted in the United States of America. The current research also used the same measuring instrument for productivity and technostress, making the results directly comparable.

According to Shin and Johnson (1978, p. 478), life satisfaction can be viewed 'as a global assessment of a person's quality of life according to his or her chosen criteria'. The literature on the effect of technostress on life satisfaction is not as abundant as that on productivity. La Torre, Esposito, Sciarra and Chiappetta (2019) did a systematic review of technostress research in 2019. They used three databases and identified 345 research articles related to technostress. After removing duplicates and articles that did not fulfil the inclusion criteria, they narrowed the number of helpful research articles to 107. Of these 107 research articles, only five addressed life satisfaction (i.e. well-being or happiness). Lee et al. (2016) defined technostress as slightly different but identified technostressors that lead to strain and theoretically affect life satisfaction. They used a three-item measure of life satisfaction based on Huebner's (1991) work. Although they did not report the average level of life satisfaction, they reported a practically significant relationship between strain and life satisfaction. An increase in strain led to a decrease in the perceived life satisfaction. Choi and Lim (2016) investigated the effect of technology overload on the psychological well-being of 419 college students in South Korea. They noted the difference between technology overload and technostress. In fact, in this research, they used the 'techno-overload' factor to measure technology overload – from the technostress measuring instrument developed by Tarafdar et al. (2007). They used seven items from the Rosenberg Self-Esteem Scale (Rosenberg, 1965) to measure psychological well-being. They did not find evidence that techno-overload affects psychological well-being (Choi & Lim, 2016). The mean score for psychological well-being was 3.806, with a standard deviation of 1.443. The measuring instrument used a 7-point Likert scale. In general, the results showed that the overall psychological well-being was rated as being only slightly above neutral. Brooks (2015) investigated the effect of social media usage on efficiency and well-being. The sample comprised undergraduate students from a prominent Western US university. The same measure of technostress was used in previous studies, based on Tarafdar et al. (2007). To measure well-being, they used a combination of the Oxford Happiness Questionnaire (Hills & Argyle, 2002), which is a condensed version of the Oxford Happiness Index and Happiness Measures (Fordyce, 1988). The Happiness Measures comprise only two items. By combining these two instruments, the author attempted to gather a more robust estimation of the factor (Brooks, 2015). A 6-point Likert scale was used to answer the items. An average score of 4.67 was attained, with an average standard deviation of 1.14. In general terms, it can be stated that this sample showed higher than average levels of life satisfaction, especially compared to Choi and Lim (2016). Because Brooks (2015) used the same measuring instrument for technostress, the results can also be compared to those discussed previously.

Van Eck (2005) studied the levels of technostress experienced by computer professionals and computer users in the Vaal Triangle area in South Africa. She found that age, qualification and gender had no significant effects on the technostress experienced. According to Riedl, Kindermann, Auinger and Javor (2012), men experience more physiological stress than women when exposed to similar ICT breakdowns designed to increase time pressure. In the research conducted by Chen (2015) on a sample of 221 Chinese knowledge workers, it was found that males experienced significantly higher levels of technostress. Ragu-Nathan, Monideepa and Bhanu (2008) got similar results using a sample of USA managers. In contrast, according to La Torre, De Leonardis and Chiappetta (2020), women experience more technostress than men. They found that women experience significantly more techno-overload, techno-invasion and techno-complexity compared to men. According to Weil and Rosen (1997), the level of computer-related experience mitigates technostress levels. The more experienced a person is, the less technostress they will experience. Kouvonen, Toppinen-Tanner, Kivisto, Huuhtanen and Kalimo (2005) got results to the contrary. According to these researchers, computer professionals with relatively more computer-related knowledge and experience will experience more technostress when faced with the challenges of working with ICTs.

Tams (2011) investigated how adults of varying ages experience workplace stress because of IT use. The results revealed that younger adults experience relatively less technostress than their older counterparts. The researcher explained that younger adults have higher levels of IT experience and higher levels of computer self-efficacy. Shu, Tu and Wang (2011) studied the effect of computer self-efficacy and computer dependency on technostress experienced using Social Cognitive Theory. They found that a practically significant relationship exists between age and technostress, in which an increase in technostress accompanied an increase in age. Like Tams (2011), they posited that this result could be ascribed to the high computer self-efficacy of younger employees. However, some contradictory results exist in the literature. Setyadi, Widagdo and Susanto (2017) found support for their research hypothesis, which stated that chronological age has no effect on technostress experienced. Similarly, La Torre et al. (2020) found no effect of age on perceived technostress.

According to Ferrer-I-Carbonell and Gowdy (2007), a non-linear relationship exists between age and life satisfaction, following a U-shaped trend. Young people experience relatively higher levels of life satisfaction, which decreases over time as they age. They reported the lowest levels of life satisfaction between the ages of 30 and 50 years, after which it increases again. In the South African context, Powdthavee (2005) found similar results. According to the research conducted by Hinks and Gruen (2007), however, no such relationship exists in the South African context. According to Clark and Oswald (1994), men and women differ in their

levels of life satisfaction. The general trend is that men report lower levels of life satisfaction compared to women. According to both Hinks and Gruen (2007) and Mahadea and Rawat (2008), however, no such trend exists in the South African context, where both genders report similar levels of life satisfaction. Craik and Salthouse (2000) postulated that older employees might be less productive than younger employees because of decreasing cognitive and perceptual abilities, as a result of the ageing process. According to Hursh, Lui and Pransky (2006, p. 46), 'if declines in performance or functional ability occur, they may be offset by accommodations or experience and may have little or no impact on productivity'.

McEvoy and Cascio (1989) conducted a meta-analysis of 96 independent studies on age and performance. This meta-analysis had a total sample size of 38 938 units. They reported a correlation of only 0.04 and concluded that all mean correlations for overall samples were relatively small. Furthermore, no evidence could be found that the type of job (professional vs. nonprofessional) influences the relationship between age and performance to any significant degree. Shoushtary, Asgarizadeh and Vahdat-zad (2012) investigated the effect of ICT on the Iranian National Oil Company's human resource productivity. The sample exceeding 11 000 units concluded that productivity was not affected by age. According to Pirkkalainen et al. (2019):

[N]one of the three control variables (gender, age, and IT experience) were found to have a significant effect on IT-enabled productivity in Model 1 and, by themselves, could explain practically none (0%) of the variance in IT-enabled productivity. (p. 1205)

Kazekami (2020) studied the mechanisms that influence the productivity of employees performing telework. Concerning the control variables, he found lower productivity levels associated with females. He also found that increased age is associated with increased productivity (Kazekami, 2020). Zhao, Xia and Huang (2020) studied the impact of technostress on productivity from the theoretical perspective of appraisal and coping, involving 513 respondents from across China. They found that their control variables (age, gender and education) had no significant impact on ICT-enabled productivity (Zhao et al., 2020). Tarafdar et al. (2010) conducted research that focussed on end-user satisfaction when using ICTs and perceived the productivity gains. The research population comprised 233 ICT users from two different organisations. The results showed that an increase in technostress decreased productivity (Tarafdar et al., 2010). Pirkkalainen et al. (2019) conducted research on a population of 846 organisational ICT users where they theorised and validated a model of deliberate proactive and instinctive reactive coping with mitigating the effects of technostress. They confirmed that an increase in technostress leads to decreased productivity (Pirkkalainen et al., 2019). According to La Torre et al. (2020) and Waizenegger, Remus and Maier (2016), knowledge workers experience technostress because of techno-invasion. The consequences may also extend beyond the individual level. If a climate is created that fosters

the factors that increase technostress, it may lead to a decrease in productivity on an individual level. However, multiple individuals being affected will also potentially harm group level and organisational performance. Lee et al. (2016) conducted research investigating the effect of technostress on productivity and life satisfaction. The research population comprised 267 Koreans, and the focus was on instant messaging after work hours. The results revealed that respondents who reported higher levels of technostress also reported higher productivity levels because of ICT usage (Lee et al., 2016). Lee et al. (2016) also found that an increase in technostress leads to decreased overall life satisfaction in Korean respondents using ICT after work hours. According to these authors, this result was in line with the results reported by Adams and King (1996). Kazekami (2020) investigated the effect of telework (i.e. working from home using ICT) on productivity and life satisfaction, amongst other factors. Although technostress was not measured directly, it was found that too long hours of telework increased the stress of balancing work and domestic chores, which ultimately leads to stress and decreased life satisfaction. La Torre et al. (2020) investigated the impact of technostress on productivity and an individual's life (similar to this research). They found productivity only to be affected by educational level, with higher educated employees reporting higher productivity levels. None of the five techno-stressors had a practically significant effect on self-reported productivity (La Torre et al., 2020). To summarise the relationship between technostress and productivity, it is clear that some inconsistencies do exist and that different studies reported different results. Overall, the tendency seems to be that an increase in technostress decreases productivity. The literature which is based on the effect of technostress on overall life satisfaction is not as abundant. All indications show that a strong negative relationship exists between technostress and overall life satisfaction, where an increase in technostress should lead to a decrease in life satisfaction.

Research approach

Brand (2009) describes positivism as:

[A] belief system arising out of practices in the natural sciences that assume that the subject of research is susceptible to being investigated objectively and that their veracity can be established with a reasonable degree of certainty. (p. 432)

Subsequently, positivists believe that all knowledge can be attained through rigorous experiments and observations (Rahi, 2017). A positivistic paradigm was utilised to establish whether technostress impacts productivity and life satisfaction (i.e. whether causal links exist and to what extent).

Research design

The research aims to determine whether technostress is correlated with productivity and life satisfaction. Therefore, a correlational research design was used. According to Dziak (2020:3), 'correlational research is a method by which people study how two or more variables are related'.

Research participants

The population of this research includes managers working at a ferrochrome smelting company. Because of the small population size of 192 managers, a census was carried out. A census attempts to elicit information from each unit of the population (Walliman, 2011). The questionnaire was sent online to 192 recipients, and 106 valid responses were received. The response rate equates to 55.2%.

Measuring instruments

An instrument developed by Chen (2015) was used to measure technostress. This instrument is based on an instrument first developed by Tarafdar et al. (2007). Chen's version of the instrument was chosen because it was adapted for Chinese knowledge workers, whereas the original instrument was US-centric. Like China, South Africa is a developing country, and it was thought best to make use of Chen's version. The instrument comprises 23 items divided into five factors aimed at measuring the five techno-stressors. According to Chen (2015, p. 72), 'all items have higher composite reliability coefficients than the benchmark value of 0.60 as recommended by Bagozzi and Yi (1988)'. This suggests high internal reliability of the data. The Average Variance Extracted (AVE) values for all factors are higher than the threshold of 0.5, indicating that adequate discriminant validity exists. Tarafdar et al. (2007) developed a factor which they defined as IT-enabled productivity, which comes close to meeting the above requirement. The face validity of the factor is clear with items such as, 'This technology helps to improve my productivity' and 'This technology helps me to perform my job better'. A Cronbach's alpha of 0.92 was calculated for the instrument. They found the instrument to have good reliability and validity.

The Riverside Life Satisfaction Scale (RLSS), developed by Margolis, Schwitsgebel, Ozer and Lyubomirsky (2018), was used in this research. This instrument is based on the Satisfaction with Life Scale (SWLS) developed by Diener, Emmons, Larson and Griffin (1985), which has been the dominant measure of life satisfaction since its creation over 30 years ago with more than 19 000 citations to date (Margolis et al., 2018). The RLSS was chosen above the SWLS because it contains multiple indirect indicators of life satisfaction, increasing the effective bandwidth of the instrument. According to Margolis et al. (2018), the McDonald's ω for the instrument ranges from 0.91 to 0.93.

Reliability of the measuring instruments

The reliability of the measuring instruments was measured using Cronbach's alpha values. Composite reliability values ranged between 0.802 and 0.943, all above 0.7, the cut-off value proposed by Nunnally and Bernstein (1994) (see Table 1).

TABLE 1: Cronbach's alphas for the scales and factors.

Scales and factors	Cronbach's alpha
Techno-complexity	0.845
Techno-overload	0.895
Techno-invasion	0.868
Techno-uncertainty	0.818
Techno-insecurity	0.802
Technostress	0.897
Productivity	0.943
Life satisfaction	0.815

Research procedure and ethical consideration

Google Forms were used as the platform to administer the questionnaire and collect the data. A link to the questionnaire was sent to all the managers forming part of the research population. Because COVID-19 lockdown restrictions were in place and most managers worked from home, 1 month was allocated for collecting the data. One week before the questionnaire closing date, a reminder was sent out to ensure a reasonable response rate. Google Forms automatically compiles the data into an easy-to-use spreadsheet format.

The research ethics committee approved the ethics application to conduct this research. The purpose of this research was clearly explained to the participants. The researcher confirmed the consent by stating that participants consented to use this information for research by completing this questionnaire.

Statistical analysis

Descriptive statistics was carried out to describe the demographic characteristics of the respondents. The first objective of the research was to establish the technostress, productivity and life satisfaction levels of managers. Descriptive statistics were calculated for all items in the questionnaire. Categorical variables were reported as frequencies and percentages. Means and standard deviations were reported for items measured on a Likert scale. The mean score represents the central tendency of a dataset, whereas standard deviation indicates the dispersion of the individual values around the mean (Levine, Stephan, & Szabat, 2016).

The second research objective was to determine if there are practically significant differences in the mean scores of technostress, productivity and life satisfaction between gender and age groups. Mean factor scores were calculated for each factor. These factor scores were summarised by reporting means and standard deviations. Factor scores were compared between various independent groups. For gender, an independent *t*-test was performed. For age groups, a one-way analysis of variance (ANOVAs) was performed. Cohen's *d* was calculated to determine significant practical differences between standardised means. Cohen's (1988) guideline values were used where an effect size of 0.2 shows a small effect or practical non-significant difference, an effect size of 0.5 reveals a medium effect or practical visible difference and, 0.8 a large effect or significant practical difference.

The third objective was to establish a correlation between technostress, productivity and life satisfaction. Spearman rank-order correlational analysis was conducted to determine the correlation coefficients between the three constructs. The absolute value of the correlations was used to determine the practical significance. Interpretations are based on Cohen's (1988) guidelines: 0.1 small effect or practically non-significant relationship; 0.3 medium effect or practically visible; and 0.5, a large effect or practically significant relationship.

All statistical tests were two-tailed, and type I error rate was set to $\alpha = 0.05$. However, because of the nature of the sample, p -values were only reported for completeness' sake. In this research, effect sizes were used for interpretation purposes.

Ethical considerations

This study was approved by Economic and Management Sciences Research Committee NWU-00795-20A4.

Results

Descriptive statistics describe the four demographic variables, namely gender, age, management level and operational unit (see Table 2). Slightly over two-thirds of the respondents were males (70.8%), whilst females made up 28.3% of the sample, and there was also one respondent who opted not to answer the question. Managers between 31 and 40 years of age comprised 34.0% of the sample, and 41–50-year-old managers made up 35.8%. Managers between 20 and 30 years of age made up about a tenth of the sample

TABLE 2: Demographic characteristics of respondents.

Demographic characteristics	Frequency	Valid Percent
Gender		
Female	30	28.3
Male	75	70.8
Prefer not to say	1	0.9
Total	106	100.0
Age category (in years)		
20–30	12	11.3
31–40	36	34.0
41–50	38	35.8
51–60	17	16.0
61–70	3	2.8
Total	106	100.0
Operational unit		
Boshhoek	12	11.3
Lion	20	18.9
Lydenburg	16	15.1
Rustenburg	26	24.5
Wonderkop	32	30.2
Total	106	100.0
Management level		
D1	25	23.6
D2–D3	41	38.7
D4–D5	8	7.5
E1	21	19.8
E2 and up	11	10.4
Total	106	100.0

(11.3%). Managers between 51 and 60 years of age made up 16% of the sample, and managers above 61 are only 2.8%. The organisation owns and operates five ferrochrome smelting plants in South Africa. Three plants are near Rustenburg and two near Steelpoort (Lion) and Lydenburg (Glencore, 2020). The responses received were relatively equally distributed between the five plants. Wonderkop represented the largest group at 30.2%, and Boshhoek was the smallest group at 11.3%. The most considerable proportion of the respondents fell at the D2–D3 level (38.7%). The next largest group was the D1 managers at 23.6%. The D4–D5 managers were the smallest group, making up only 7.5% of the sample. E1 managers, who typically also carry the title of Manager in the organisation, made up 19.8% of the sample. Senior management made up 10.4% of the sample.

The mean scores of the technostress scale and factors vary between 2.03 and 3.27. The productivity mean score is 4.04 with an standard deviation (SD) of 0.86, whilst the means score of life satisfaction is 3.46 with an SD of 0.82. The mean scores and standard deviations are depicted in Table 3.

An independent t -test was done to compare the mean scores between gender groups, whilst an ANOVA was done to compare the mean scores between age groups (see Table 4). For completeness, p -values will be reported but not interpreted because a census was used and not random sampling.

TABLE 3: Mean scores and standard deviations of the scales and factors.

Scales and factors	M	SD
Techno-complexity	2.07	1.08
Techno-overload	3.18	1.32
Techno-invasion	3.19	1.41
Techno-uncertainty	3.27	1.11
Techno-insecurity	2.03	1.16
Technostress	2.71	1.35
Productivity	4.04	0.86
Life satisfaction	3.46	0.82

M, Mean; SD standard deviation.

TABLE 4: Comparison between male and female respondents.

Scales and factors	Gender	N	M	SD	p	Effect size
Techno-overload	Female	30	3.03	1.23	0.440	0.150
	Male	75	3.21	1.02	-	-
Techno-complexity	Female	30	2.02	0.95	0.479	0.070
	Male	75	2.08	0.78	-	-
Techno-invasion	Female	30	3.25	1.19	0.720	0.070
	Male	75	3.16	1.20	-	-
Techno-uncertainty	Female	30	3.18	0.84	0.743	0.130
	Male	75	3.29	0.86	-	-
Techno-insecurity	Female	30	2.07	0.85	0.738	0.050
	Male	75	2.03	0.68	-	-
Productivity	Female	30	4.01	0.77	0.737	0.050
	Male	75	4.05	0.82	-	-
Life satisfaction	Female	30	3.42	0.91	0.558	0.060
	Male	75	3.48	0.72	-	-
Technostress	Female	30	2.71	0.74	0.554	0.060
	Male	75	2.76	0.62	-	-

M, mean; SD, standard deviation.

The largest effect size recorded was only 0.150 (for techno-overload). Therefore, only practically non-significant differences were found between the eight factors when comparing males and females. This means that there are no discernible differences in opinion between males and females.

There were only three respondents in the 61–70 group; hence they were combined with the 51–60 group to form category 51–70 (see Table 5). The mean score for techno-overload increased as the age of the respondents decreased. However, the largest effect size recorded was only 0.21, which means that all these differences are practically non-significant. For techno-complexity, more significant differences were observed. The mean score for the 20–30 age group was 1.93 (SD = 1.00), and for the 31–40 age group, it was 1.85 (SD = 0.82). The mean for the 41–50 age group was 2.11 (SD = 0.71). Between these three age groups, no practically

significant differences exist ($d = 0.09$ – 0.32). Considering that respondents from the younger age groups have been exposed more extensively to technological advancements, this result makes sense. The mean score for the 51–70 age group was 2.47 (SD = 0.83). Practically visible differences exist between this age group and the 20–30 and 41–50 groups, with effect sizes of 0.54 and 0.43. Between the 31–40 age group and the 51–70 age group, an effect size of 0.75 was recorded, which shows that a practically significant difference exist. Although the oldest group of respondents reported higher levels of perceived techno-complexity than the other age groups, the mean value was still below 3.00 ($M = 2.47$), which means they do not perceive techno-complexity to be adding to overall feelings of technostress. The education level and experience of the respondents might have contributed to this result. No significant effect sizes were recorded for techno-invasion. The largest effect size was 0.28, recorded between the 41–50

TABLE 5: Comparison between age groups.

Scales and factors	Age groups	N	M	SD	p		Effect size		
					ANOVA	Welch	20–30	31–40	41–50
Techno-overload	20–30	12	3.32	1.37	0.874	0.887	-	-	-
	31–40	36	3.23	1.05			-	-	-
	41–50	38	3.14	1.08			-	-	-
	51–70	20	3.03	1.04			-	-	-
	Total	106	3.17	1.09			-	-	-
Techno-complexity	20–30	12	1.93	1.00	0.050	0.079	-	-	-
	31–40	36	1.85	0.82			-	-	-
	41–50	38	2.11	0.71			-	-	-
	51–70	20	2.47	0.83			-	-	-
	Total	106	2.07	0.82			-	-	-
Techno-invasion	20–30	12	3.04	1.38	0.666	0.678	-	-	-
	31–40	36	3.15	1.17			-	-	-
	41–50	38	3.38	1.11			-	-	-
	51–70	20	3.01	1.28			-	-	-
	Total	106	3.19	1.19			-	-	-
Techno-uncertainty	20–30	12	2.83	0.81	0.150	0.142	-	-	-
	31–40	36	3.17	0.88			-	-	-
	41–50	38	3.41	0.90			-	-	-
	51–70	20	3.43	0.67			-	-	-
	Total	106	3.27	0.85			-	-	-
Techno-insecurity	20–30	12	2.08	1.05	0.704	0.639	-	-	-
	31–40	36	2.09	0.74			-	-	-
	41–50	38	2.06	0.67			-	-	-
	51–70	20	1.86	0.63			-	-	-
	Total	106	2.03	0.73			-	-	-
Productivity	20–30	12	4.21	0.77	0.766	0.778	-	-	-
	31–40	36	4.08	0.77			-	-	-
	41–50	38	4.02	0.83			-	-	-
	51–70	20	3.91	0.86			-	-	-
	Total	106	4.04	0.80			-	-	-
Life satisfaction	20–30	12	3.32	0.73	0.889	0.883	-	-	-
	31–40	36	3.48	0.76			-	-	-
	41–50	38	3.51	0.79			-	-	-
	51–70	20	3.42	0.83			-	-	-
	Total	106	3.46	0.77			-	-	-
Technostress	20–30	12	2.64	0.87	0.814	0.838	-	-	-
	31–40	36	2.70	0.62			-	-	-
	41–50	38	2.82	0.63			-	-	-
	51–70	20	2.76	0.64			-	-	-
	Total	106	2.75	0.65			-	-	-

M, mean; SD, standard deviation; ANOVA, analysis of variance.

($M = 3.38$, $SD = 1.11$) and 51–70 ($M = 3.01$, $SD = 1.28$) age groups. This result means the respondents are experiencing slight levels of techno-invasion, which are adding to perceived levels of technostress. The mean scores for techno-uncertainty were 2.83 ($SD = 0.81$) for the 20–30 age group, 3.17 ($SD = 0.88$) for the 31–40 age group, 3.41 ($SD = 0.90$) for the 41–50 age group and 3.43 ($SD = 0.67$) for the 51–70 age group, whilst the 20–30 age group is the only group with a mean score of less than 3.00. The other three groups, and especially the older two groups, scored above 3.00. This means that the two older age groups, in particular, perceive techno-uncertainty, and it is contributing to feelings of technostress. The effect size between the 20 and 30 age group and the 41–50 age group was 0.64, showing a practically visible difference. Similarly, the effect size between the 20–30 age group and the 51–70 age group was 0.73, signifying that the difference leaned towards being practically significant. For techno-insecurity, the largest effect size measured between the groups was only 0.31. This result means there are practically no significant differences between the mean scores of the four age groups. For productivity, the largest effect size recorded was 0.34. This result indicates there are no practically significant differences between the mean scores of the four age groups. For life satisfaction, the largest effect size measured was 0.24, indicating practically no significant differences in the mean scores of the four age groups. Mean scores from the five techno-stressors were combined to calculate the aggregate technostress score. The largest effect size measured was only 0.20, indicating practically non-significant differences between the age groups.

Spearman rank-order correlational analyses were conducted to determine the correlation coefficients between technostress, productivity and life satisfaction (see Table 6). The correlation coefficient between technostress and productivity is only -0.112 . There is a practically non-significant relationship between technostress and productivity. The literature reviewed pointed towards a negative relationship between these two factors. The results of this research points towards a negative relationship, albeit practically non-significant. The correlation coefficient between technostress and life satisfaction is -0.245 . This result indicates that a negative relationship exists between technostress and life satisfaction, in that an increase in technostress leads to a decrease in life satisfaction. The relationship is approaching a practically visible effect. This result coincides with existing literature. The correlation coefficient between techno-overload and productivity is -0.049 . Techno-overload does not seem to impact productivity. The correlation coefficient between techno-overload and life satisfaction is -0.155 . An increase in techno-overload will lead to decreased life satisfaction, but the effect is practically non-significant. The correlation coefficient between techno-complexity and productivity is -0.361 . An increase in techno-complexity leads to a decrease in self-reported productivity. The effect is practically visible. The correlation coefficient between techno-complexity and life satisfaction is -0.197 . An increase in techno-complexity leads to a decrease in life satisfaction. The effect is small, approaching practically visible levels. The correlation coefficient between techno-invasion and productivity is -0.150 . An increase in techno-invasion leads to a decrease in self-reported productivity. The effect is small and

TABLE 6: Correlation between technostress, productivity and life satisfaction.

Scales and factors	1. Techno overload	2. Techno complexity	3. Techno invasion	4. Techno uncertainty	5. Techno insecurity	6. Technostress	7. Productivity	8. Life Satisfaction
1 Techno overload								
Correlation Coefficient	1.000	-	-	-	-	-	-	-
<i>p</i>	-	-	-	-	-	-	-	-
2 Techno complexity								
Correlation Coefficient	0.366**	1	-	-	-	-	-	-
<i>p</i>	0.000	-	-	-	-	-	-	-
3 Techno invasion								
Correlation Coefficient	0.603**	0.404**	1	-	-	-	-	-
<i>p</i>	0.000	0.000	-	-	-	-	-	-
4 Techno uncertainty								
Correlation Coefficient	0.377**	0.117	0.177	1	-	-	-	-
<i>p</i>	0.000	0.233	0.069	-	-	-	-	-
5 Techno insecurity								
Correlation Coefficient	0.398**	0.486**	0.191*	0.313**	1	-	-	-
<i>p</i>	0.000	0.000	0.050	0.001	-	-	-	-
6 Technostress								
Correlation Coefficient	0.818**	0.656**	0.743**	0.541**	0.619**	1	-	-
<i>p</i>	0.000	0.000	0.000	0.000	0.000	-	-	-
7 Productivity								
Correlation Coefficient	-0.049	-0.361**	-0.150	0.306**	-0.108	-0.112	1	-
<i>p</i>	0.617	0.000	0.126	0.001	0.273	0.252	-	-
8 Life Satisfaction								
Correlation Coefficient	-0.155	-0.197*	-0.207*	-0.058	-0.245*	-0.245*	0.247*	1
<i>p</i>	0.112	0.043	0.034	0.554	0.011	0.011	0.011	-

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

* , Correlation is significant at the 0.05 level (2-tailed).

practically non-significant. The correlation coefficient between techno-invasion and life satisfaction is -0.207 . An increase in techno-invasion leads to a decrease in life satisfaction. The effect is small, approaching practically visible levels. The correlation coefficient between techno-uncertainty and productivity is 0.306 . An increase in techno-uncertainty leads to an increase in self-reported productivity. The effect is medium and practically visible. This result is somewhat unexpected. Constant improvements in the technology used increase techno-uncertainty but seemed to be associated with increased productivity. The correlation coefficient between techno-uncertainty and life satisfaction is -0.058 . An increase in techno-uncertainty leads to a decrease in life satisfaction. The effect is small, approaching a level of being practically visible. The correlation coefficient between techno-insecurity and productivity is -0.108 . An increase in techno-insecurity leads to a decrease in self-reported productivity. The effect is small and practically non-significant. The correlation coefficient between techno-insecurity and life satisfaction is -0.245 . An increase in techno-insecurity leads to a decrease in life satisfaction. The effect is medium and approaching levels of being practically visible. To summarise, productivity is best correlated with techno-complexity and techno-uncertainty. The other three techno-stressors are weakly correlated with productivity. Increases in techno-complexity decrease self-reported productivity, whereas increases in techno-uncertainty increases productivity. Life satisfaction is best correlated with techno-complexity, techno-invasion and techno-insecurity. In all three instances, an increase in the respective techno-stressor leads to a decrease in life satisfaction.

Discussion

The mean score for the techno-complexity factor was only 2.07 , which is significantly lower compared to the findings of Tarafdar et al. (2010) ($M = 2.54$); Pirkkalainen et al. (2019) ($M = 2.51$) and Brooks (2015) ($M = 2.45$). This result shows that the complexity of ICT is not adding to perceptions of stress. The respondents are on the management level, meeting competency requirements related to education level and experience.

The mean score for the techno-overload this factor was 3.18 , indicating a slight agreement that ICT usage is causing feelings of overload. This correlated with the finding of Brooks (2015) ($M = 3.20$). The mean score for techno-invasion was 3.19 , indicating that there is a slight agreement that techno-invasion contributes to perceptions of stress. The mean score for techno-uncertainty was 3.27 (close to neutral), slightly higher than Tarafdar et al. (2010) finding of 3.15 . This result shows that techno-uncertainty are contributing most to the feelings of technostress for managerial employees. The mean score for the techno-insecurity factor was 2.03 compared to 2.00 of Tarafdar et al. (2010) and 2.34 of Pirkkalainen et al. (2019). The managerial employees seem to have high self-efficacy as related to dealing with demands arising from ICT usage. Both in terms of techno-complexity

and techno-insecurity, their abilities and competency are decreasing perceived levels of technostress. The mean score across all the technostress statements was 2.71 . This result reveals that managerial employees, on average, experience low levels of technostress. The factor mean for productivity was 4.04 , similar to the 4.06 of Pirkkalainen et al. (2019) and slightly higher than the 3.8 found by Tarafdar et al. (2010). The mean score shows that ICT usage contributes considerably to the productivity levels of managerial employees. The mean score for this life satisfaction was 3.46 . This result reveals that the managers, on average, are satisfied with their lives.

No practically significant differences exist for any of the factors between males and females. This correlates with the results of Van Eck, whilst Riedl et al. (2012), Ragu-Nathan et al. (2008) and Chen (2015) found that males experienced higher levels of technostress. However, La Torre et al. (2020) found that women experience more techno-overload, techno-invasion, and techno-complexity than men. Managerial employees between 31 and 40 years of age scored only 1.85 for techno-complexity, whereas their colleagues between the ages of 51 and 70 scored 2.47 . Managerial employees between 20 and 30 years of age scored only 2.83 for techno-uncertainty, whereas their colleagues between the ages of 51 and 70 scored 3.42 . The degree to which techno-uncertainty is experienced is increasing with age. Shu et al. (2011) found similar results that an increase in technostress is increasing with age. Tams (2011) findings showed that younger adults experience less technostress than their older counterparts, whilst Setyadi et al. (2017) and La Torre et al. (2020) found no effect of age on perceived technostress. Similar to this study, Zhao et al. (2020), Shoushtary et al. (2012) and Pirkkalainen et al. (2019) found that gender and age had no significant impact on ICT-enabled productivity. Hinks and Gruen (2007) and Mahadea and Rawat (2008) correlate with the findings of this study that gender had similar life satisfaction levels.

The results reveal that technostress does not affect productivity. Although a negative correlation exists, it is practically non-significant. These results correlate with La Torre et al. (2020) findings, which revealed that none of the five techno-stressors had a practically significant effect on self-reported productivity. However, Lee et al. (2016) found that higher technostress leads to higher productivity levels and decreased overall life satisfaction.

The correlation coefficient between technostress and life satisfaction is -0.245 . This result shows that a negative relationship exists between technostress and life satisfaction, in that an increase in technostress leads to a decrease in life satisfaction. Adams and King (1996) and Kazekami (2020) also found that long hours of telework (ICT) lead to stress and decreased life satisfaction. It is noted that this correlation is approaching the effect of being practically visible. The techno-stressors were also analysed separately to determine their correlations with productivity and life satisfaction.

Productivity is best correlated with techno-complexity and techno-uncertainty. Increases in techno-complexity decrease self-reported productivity, whereas increases in techno-uncertainty increases productivity. Life satisfaction is best correlated with techno-complexity, techno-invasion and techno-insecurity. In all three instances, an increase in the respective techno-stressor leads to a decrease in life satisfaction.

Practical implications

Techno-uncertainty and techno-complexity seem to be more prevalent in older managerial employees. From the correlation analyses conducted, techno-complexity is decreasing self-reported levels of productivity. Strategies to reduce techno-complexity, especially for older managerial employees, should be considered. This might involve giving additional training and providing more assistance. Techno-invasion is highly correlated with life satisfaction. As expected, they are also reporting low levels of life satisfaction. Strategies should be investigated and employed to decrease perceived techno-invasion, leading to higher levels of life satisfaction.

Limitations and recommendations

A particular research population characterises this research. Therefore, although this allows for a detailed and population-specific investigation, it limits the degree to which the results can be extrapolated to other populations. A correlational research design was utilised, inheriting the advantages and disadvantages associated with this approach. One of these disadvantages is the inability to determine cause-and-effect relationships. This means that although it was found that a negative correlation exists between technostress and life satisfaction, it is not a sufficient evidence to conclude that technostress is indeed leading to reduced life satisfaction.

There is one result that stands out as being unexpected – the correlation between techno-uncertainty and productivity. According to the results, increased techno-uncertainty increases productivity, and the result is practically visible. The techno-uncertainty factor supposedly measures the incremental technostress experienced because of the stress of being constantly exposed to technological updates. Looking at the statements within this sub-factor, it only measures the rate of new technology introduction, whether in hardware, software or network upgrades. The inherent assumption is that those new technologies increase perceived technostress, but it is not necessarily true. Introducing new technologies might also decrease perceived technostress. Future research should critically evaluate this factor for applicability. Limited measuring instruments exist for technostress. The assumption is made that the technostress experienced is the aggregate of the scores for the individual techno-stressors. Mathematically, each techno-stressor contributes to the overall technostress score in proportion to the number of questions. These contributions might distort the outcome. It is suggested to explore further this question, which techno-stressors contribute the most to feelings of technostress. Lastly, it is

recommended to evaluate the scope of future studies critically. In this research, the focus was on managerial employees, for whom technostress does not seem to be a major concern. Employees who are not on managerial levels might be more exposed to the effects of technostress for various reasons. Lower levels of employment (those levels slotting in between managers and floor staff) should be involved, and that specific technology is targeted with the questionnaire (not ICT in general). This will also assist significantly in developing targeted organisational interventions.

Conclusion

Research has shown that ICT advances are causing technostress. The study's purpose was to investigate the impact of technostress on the managers' productivity and overall life satisfaction in ferrochrome smelters. There is limited research that has been conducted on technostress in a South African context, especially amongst managers exposed to ICT. A quantitative paradigm using a correlational design was appropriate in answering the research questions. The main findings were that managers experience low levels of technostress, high levels of IT-enabled productivity and above-average life satisfaction. No practically significant differences exist for any research factors between males and females, whilst techno-complexity and techno-uncertainty increase with age. Technostress does not affect productivity, but a negative relationship exists between technostress and life satisfaction. Techno-uncertainty and techno-complexity had a higher prevalence amongst older managerial employees. Techno-complexity decreases the self-reported levels of productivity. Strategies such as providing training and assistance to reduce techno-complexity for older managerial employees should be considered. This study confirmed the negative impact of ICT on life satisfaction.

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Authors' contributions

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Data availability

The data that support the findings of this study are available from the corresponding author (P.A.B) upon reasonable request.

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