

Technostress, Cyberloafing, and Student Satisfaction: A Moderated Mediation Examination in Higher Education

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Abstract

This study investigates how technostress and cyberloafing in technology-rich universities influence student satisfaction through academic procrastination and under varying levels of social pressure, drawing on Social Cognitive Theory and addressing inconsistent findings on the attitudinal consequences of digitalisation in higher education. Using a cross-sectional online survey of 2,111 Diploma, Bachelor, Master, and Doctoral students from universities in East and Central Java, Indonesia, the study measured technostress, multidimensional cyberloafing, academic procrastination, social pressure, and student satisfaction with validated Likert-type scales and tested a moderated mediation model using PLS-SEM, including full measurement validation, mediation and moderation analysis, blindfolding, IPMA, and PLSpredict. The results show that technostress and cyberloafing both increase academic procrastination ($\beta = 0.152$ and $\beta = 0.480$, $p < 0.001$), while procrastination substantially reduces student satisfaction ($\beta = -0.284$, $p < 0.001$); in contrast, technostress and cyberloafing have no significant direct effects on satisfaction but exert significant negative indirect effects via procrastination ($\beta = -0.043$ and $\beta = -0.137$, $p < 0.001$). Social pressure significantly strengthens the negative association between procrastination and satisfaction ($\beta = -0.097$, $p = 0.001$), and the model explains 38 percent of the variance in academic procrastination and 7.8 percent of the variance in student satisfaction, with moderate predictive accuracy for procrastination. The study contributes an integrated, theory-driven account that positions academic procrastination as the central self-regulatory bridge between digital strain, off-task online behaviour, and satisfaction, and introduces social pressure as a culturally salient boundary condition in a large Global South sample, while highlighting the need for future longitudinal and cross-cultural work and for institutional interventions that simultaneously reduce technostress, manage cyberloafing, strengthen self-regulation, and calibrate performance expectations.

INTRODUCTION

The rapid digitalisation of higher education has fundamentally reshaped how students access learning, interact socially, and obtain academic support. Learning management systems, video-conferencing platforms, and social media now underpin university study, enabling flexible access to resources and collaboration. This transformation has created an important paradox for higher education: the same technologies that support flexible and connected learning can also generate psychological strain, attentional fragmentation, and self-regulatory difficulty. Technostress, understood as the strain arising when individuals feel overloaded, invaded, or constrained by ICTs, represents one major expression of this paradox. Recent studies show that technostress among university students is linked to reduced academic motivation, lower psychological well-being, diminished productivity, impaired sleep quality, heightened burnout, and weaker commitment to study as students manage constant connectivity, information overload, and complex digital tools (Vallone et al., 2023; Kumar et al., 2024; Chukwuere, 2024; Yao & Wang, 2023; Mangundu, 2023; Daud, 2025). These findings indicate that digitalisation should be examined not only as an instructional innovation, but also as an environmental demand that may affect students' capacity to regulate academic engagement.

At the behavioural level, the ubiquity of networked devices has normalised cyberloafing, that is, using the internet for non-academic purposes during study or class time. Among university students, cyberloafing is expressed through social sharing, online shopping, real-time updating, entertainment consumption, and gaming, and higher levels are associated with greater fatigue, weaker cognitive engagement, and poorer learning outcomes (Krishna et al., 2023; Levkov & Kitanovikj, 2024; Agrawal & Krishna, 2025). Cyberloafing is also linked to elevated anxiety and a reduced sense of meaning or purpose, particularly when students lack psychological flexibility and self-regulatory skills (Li et al., 2022; Nweke et al., 2024). These forms of digital distraction intersect with academic procrastination, a self-regulatory difficulty consistently associated with emotional distress, poorer academic performance, lower life satisfaction, reduced self-efficacy, emotional exhaustion, and compromised psychological health (González-Brignardello & Sánchez-García, 2023; Ghasempour et al., 2024; Rad et al., 2025; Carranza Esteban et al., 2023; Demir & Kuşcu Karatepe, 2025; Savaş et al., 2025). Because student satisfaction is a core indicator of educational quality and a predictor of persistence, academic success, and institutional reputation, understanding how digital strain and digital distraction become dissatisfaction is a significant issue for higher education research and practice (Ekawati et al., 2025).

Although this literature is expanding, the research gap remains clear in three respects. First, studies on technostress, cyberloafing, and academic procrastination often develop in parallel, so the links among technology-induced strain, off-task online behaviour, and delayed academic action remain more descriptive than explanatory. Second, existing findings on digitalisation and student satisfaction are inconsistent. Technostress is frequently associated with emotional strain, reduced motivation, and poorer perceived quality of online learning (Saleem et al., 2024; Cazan et al., 2024), yet challenge and hindrance perspectives and techno-eustress research suggest that some technology-related demands may coexist with, or even enhance, satisfaction and engagement when students appraise them as opportunities rather than threats (Zhao et al., 2023; Nascimento et al., 2024; Lallmahomed, 2025). Other findings report that technostress does not significantly predict satisfaction with online study after competing variables are controlled (Cataldo et al., 2023). These mixed results indicate that the technostress-satisfaction relationship cannot be adequately understood through direct effects alone and requires attention to mediating mechanisms and boundary conditions.

Third, ambiguity also characterises the cyberloafing literature. Most studies with university samples describe cyberloafing as detrimental by linking off-task online behaviour to academic stress, fatigue, weaker engagement, and lower learning satisfaction (Metin-Orta & Demirtepe-Saygılı, 2023; Nweke et al., 2024; Agrawal & Krishna, 2025). However, evidence from organisational and health-care settings suggests that cyberloafing can also function as a micro-break that supports recovery, creativity, and psychological well-being, or may show no clear association with core outcomes (Kwala & Agoyi, 2024; Aciksoz et al., 2024; Lim & Teo, 2024). Some scholars further suggest that students may use cyberloafing to alleviate technostress, although systematic tests of this proposition remain rare (Karali et al., 2024). Recent work has begun to connect academic stress, cyberloafing, and procrastination in one framework (Asghar & Tariq, 2025), but the joint influence of technostress and cyberloafing on student

satisfaction through a self-regulatory mechanism remains insufficiently theorised and empirically underexplored.

Academic procrastination provides a theoretically important mechanism for addressing this gap. Procrastination is not simply another negative student behaviour; it represents a failure of self-regulation that can translate digital strain and digital distraction into poorer evaluations of the learning experience. Prior research shows that academic procrastination undermines well-being and is negatively related to satisfaction, partly through reduced self-efficacy and increased exhaustion (Carranza Esteban et al., 2023; Tian et al., 2024). Nevertheless, only limited studies have modelled procrastination as a mediator between technology-related variables and satisfaction or performance, and these studies have largely centred on social media addiction rather than technostress or cyberloafing (Kutluay & Karaca, 2025; Abd Aziz et al., 2023). Thus, existing research explains that technostress, cyberloafing, procrastination, and satisfaction are related, but it has not yet sufficiently explained how technology-related environmental demands and digitally enabled behavioural diversion converge into a common self-regulatory pathway that affects student satisfaction.

A further unresolved issue concerns the role of social pressure. Research in Asian and other collectivist contexts shows that strong social and familial expectations to excel academically shape students' motivation, coping, and adjustment (Li & Xie, 2020; Ardi et al., 2022; Garcia et al., 2024). Although social support and self-regulated learning can buffer such pressure (Suud et al., 2025), empirical work rarely examines whether social pressure conditions the effect of procrastination on satisfaction within technology-intensive learning environments. Theoretically, social pressure should specifically moderate the procrastination-satisfaction relationship because procrastination creates a discrepancy between expected and actual academic behaviour. When students experience high expectations from significant others, this discrepancy becomes more socially evaluative and may intensify guilt, self-criticism, fear of negative evaluation, and dissatisfaction. Under lower social pressure, the same delay may remain a private self-regulatory difficulty with weaker implications for global satisfaction. Therefore, social pressure is not treated as a general background variable in this study, but as a contextual condition that shapes the evaluative consequences of procrastination.

To address these gaps, the present study draws on Social Cognitive Theory to develop a moderated mediation model linking technostress, cyberloafing, academic procrastination, social pressure, and student satisfaction. Social Cognitive Theory is suitable because it explains academic functioning through the reciprocal interplay of environmental conditions, behavioural responses, self-regulatory processes, and evaluative outcomes. In this model, technostress is conceptualised as a technology-related environmental demand, cyberloafing as a digitally enabled behavioural response, academic procrastination as the focal self-regulatory mechanism, student satisfaction as the evaluative outcome, and social pressure as a normative environmental condition that recalibrates how students interpret procrastination. Building on evidence that technostress and cyberloafing contribute to emotional strain, self-regulatory difficulties, and inconsistent satisfaction outcomes, this framework specifies how digital demands and off-task digital behaviour may undermine satisfaction primarily when they impair task

regulation (Abd Aziz et al., 2023; Cazan et al., 2024; Agrawal & Krishna, 2025). Academic procrastination is therefore positioned as the central mediating mechanism, extending prior work that examined procrastination's effects on satisfaction or performance largely in isolation (Carranza Esteban et al., 2023; Tian et al., 2024). Social pressure from significant others is incorporated as a contextual moderator of the procrastination-satisfaction relationship, responding to calls to treat family and societal expectations as key boundary conditions in collectivist settings (Ardi et al., 2022; Garcia et al., 2024; Suud et al., 2025).

The originality of this study does not rest merely on assembling familiar constructs, but on specifying a conditional self-regulation mechanism that clarifies why direct relationships between digital stressors, digital distraction, and satisfaction may appear inconsistent across prior studies. The proposed model advances current knowledge by showing that technostress and cyberloafing should be understood as different but complementary antecedents of academic procrastination. Technostress reflects digitally mediated environmental strain, whereas cyberloafing reflects digitally enabled behavioural diversion. Their integration is theoretically meaningful because both pathways converge on students' capacity to initiate, sustain, and complete academic tasks. Student satisfaction is consequently treated not as a simple reaction to technology use, but as a downstream appraisal shaped by whether digital demands and distractions become persistent procrastination and whether that procrastination occurs under strong social pressure. This logic moves the literature beyond a replication and extension exercise by converting separate construct-level associations into an explanatory and conditional process model.

Accordingly, this study addresses the following research questions. RQ1 asks: How do technostress and cyberloafing influence academic procrastination and student satisfaction in technology-rich higher education? RQ2 asks: Does academic procrastination mediate the relationships between technostress and student satisfaction and between cyberloafing and student satisfaction? RQ3 asks: Does social pressure strengthen the negative relationship between academic procrastination and student satisfaction? RQ4 asks: What theoretical and practical insights are gained by testing this moderated mediation model in an Indonesian higher education context? Empirically, the study uses a large multi-institutional student sample and variance-based structural equation modelling, enabling simultaneous estimation of direct, indirect, and interaction effects in line with recent PLS-SEM guidelines emphasising explanatory and predictive assessment (Hair et al., 2021).

This study offers several contributions to the literature on digitalisation and student experience. First, it integrates technostress and cyberloafing into a single theoretically grounded framework and explains their influence on student satisfaction through academic procrastination, thereby helping reconcile inconsistent findings on the consequences of digital strain and digital distraction (Cataldo et al., 2023; Nascimento et al., 2024; Lim & Teo, 2024). Second, by foregrounding academic procrastination as a core self-regulatory mediator, the study advances procrastination research beyond simple predictor-outcome models and situates it within contemporary digital learning environments (Tian et al., 2024; Agrawal & Krishna, 2025). Third, the inclusion of social pressure as a moderator clarifies when procrastination becomes especially detrimental for satisfaction, enriching emerging work on how familial and societal

expectations shape student adjustment in technology-intensive higher education (Ardi et al., 2022; Suud et al., 2025). Finally, by providing evidence from Indonesian universities, the study contributes needed insights from a Global South, collectivist context that remains under-represented in technostress and cyberloafing research, supporting a more globally inclusive understanding of how digital demands and distractions affect student satisfaction.

THEORETICAL FRAMEWORK AND HYPOTHESIS

2.1 Social Cognitive Theory (SCT)

Social Cognitive Theory (SCT) explains academic functioning through triadic reciprocal determinism, in which environmental influences, personal cognitive processes, and behaviour continuously shape one another (Bandura, 1986, 1997; Bembenutty et al., 2024). In this study, SCT is not used only as a broad background theory, but as a process logic for explaining how technology-rich learning environments influence students' behavioural regulation and evaluative outcomes. Technostress (TS) is treated as an environmental demand because digital overload, invasion, and complexity can reduce perceived control, weaken technology-related self-efficacy, and make academic tasks appear more difficult or less manageable. Social pressure (SP) is also treated as an environmental determinant because expectations from peers, family, lecturers, and significant others provide normative feedback that shapes students' self-standards and outcome expectations. Cyberloafing (CL) and academic procrastination (APC) are behavioural manifestations of self-regulation. CL reflects a digitally enabled behaviour that is reinforced by immediate relief or enjoyment, while APC reflects a failure to initiate or sustain goal-directed academic action. Student satisfaction (SS) is positioned as an evaluative outcome because it reflects students' appraisal of whether their learning experience supports competence, progress, and fulfilment.

This mapping clarifies the mechanisms behind the model. Under SCT, students do not respond mechanically to digital demands; rather, they interpret those demands through self-efficacy, perceived control, outcome expectations, and learned behavioural scripts. In demanding digital contexts, TS can undermine perceived control and deplete self-regulatory resources, which increases avoidance and makes off-task digital behaviour more attractive (Saleem et al., 2024). Empirical work shows that TS can trigger cyberslacking through deficient self-control and burnout, and that academic stress may elevate CL, which then promotes procrastination (Li & Liu, 2022; Nweke et al., 2024). These findings are consistent with an SCT sequence in which environmental strain weakens self-regulation, repeated behaviour becomes reinforced, and delayed academic action becomes more likely. Within this logic, APC is the central behavioural mechanism that converts strain and distraction into lower satisfaction by disrupting flow, perceived competence, and positive learning appraisals (Öztekin et al., 2025).

SCT also recognises social persuasion, modelling, and normative feedback as environmental influences that recalibrate self-evaluation and behaviour (Chao et al., 2025). Thus, SP is theoretically relevant because students evaluate procrastination not only against personal standards, but also against salient social expectations. Normative controls may discourage CL and reinforce task engagement, while high-

pressure expectations may also intensify the negative emotional meaning of delay (Mihelič et al., 2023). To avoid stretching SCT beyond its most parsimonious explanation, the moderation argument is further informed by social comparison, expectancy, expectation-violation, and self-determination perspectives. These perspectives clarify why procrastination becomes more damaging under high SP: students compare their delayed performance with perceived standards, experience the delay as a violation of expected achievement, and may feel controlled rather than autonomously motivated (Festinger, 1954; Vroom, 1964; Burgoon, 1993; Deci & Ryan, 2000). Accordingly, the proposed model integrates SCT with complementary motivational and normative mechanisms while retaining SCT as the overarching framework.

2.2 The relationship between Technostress (TS) and Academic Procrastination (APC)

Within SCT, TS should increase APC because it undermines the personal determinants needed for self-regulated learning. Digital overload and complexity can lower students' confidence that they can complete academic work efficiently, while techno-invasion can blur study and rest boundaries and reduce perceived control. When students expect digital tasks to be effortful, confusing, or emotionally aversive, avoidance becomes a more attractive short-term response. TS is therefore conceptualised as a technology-induced strain that arises when digital demands such as techno-overload, techno-invasion, and techno-complexity exceed students' coping resources, thereby depressing motivation and heightening anxiety in higher education (Vallone et al., 2023; Cazan et al., 2024; Saleem et al., 2024). Procrastination, in turn, reflects a mood-regulatory and self-control failure that becomes more likely under elevated negative affect and ego depletion; large-sample evidence shows that state anxiety predicts APC via ego depletion (Fan et al., 2024). Mechanistically, TS fosters APC by increasing cognitive overload and affective strain that erode self-regulatory capacity and task engagement. Empirically, techno-overload has been positively linked to APC among undergraduates (Grogan & Wipawayangkool, 2025), and related digital strain such as digital burnout is likewise associated with greater APC (Savaş et al., 2025). Convergent findings in non-student samples further indicate that TS dimensions correlate positively with procrastination tendencies (Sheikh & Zahur, 2024). Accordingly, we hypothesise:

H1: Technostress has a positive effect on Academic Procrastination.

2.3 The relationship between Cyberloafing (CL) and Academic Procrastination (APC)

SCT treats behaviour as shaped by reinforcement, modelling, and self-regulatory standards. CL, defined as using the internet for non-academic purposes during study time, fits this logic because it offers immediate rewards such as entertainment, social connection, temporary relief from boredom, or escape from difficult tasks. These short-term reinforcements can gradually weaken students' self-monitoring

and make task delay more habitual. CL therefore operates as a short-term avoidance and mood-repair strategy that diverts attention from focal tasks and undermines self-regulation, which are well-known antecedents of procrastination in academic contexts (Bibi et al., 2025; Krishna & Agrawal, 2023). Recent evidence documents a direct and sizable link from CL to APC: in a bootstrapped structural model with 489 students, CL positively predicted procrastination and partially transmitted the effect of depleted willpower on delay, indicating that off-task digital activity channels self-regulatory weakness into procrastination (Güleç & Yıldız, 2024). In university samples, CL also emerges as the proximal mechanism by which academic stress becomes procrastination, with significant positive correlations among stress, CL, and procrastination and a confirmed mediating effect of CL (Asghar & Tariq, 2025). Mechanistically, CL lowers cognitive engagement and increases psychological detachment in class, which erode task focus and make postponement more likely (Levkov & Kitanovikj, 2024). Convergent findings show that CL co-occurs with problematic smartphone use and reduced self-control, while smartphone addiction itself heightens the probability of procrastination, situating CL within a broader self-regulatory deficit that culminates in academic delay (Bibi et al., 2025; Zhang & Zeng, 2024). Studies in higher education additionally document that CL degrades learning processes and well-being (Krishna & Agrawal, 2023). Together, this theoretical and empirical logic leads to the following hypothesis:

H2: Cyberloafing has a positive effect on Academic Procrastination.

2.4 The relationship between Academic Procrastination (APC) and Student Satisfaction (SS)

APC is a prototypical self-regulatory failure that delays task initiation and completion, compresses effort into short time windows, and elevates negative affect. From an SCT perspective, repeated delay weakens mastery experiences, reduces academic self-efficacy, and creates negative outcome expectations, all of which can lower students' evaluations of their courses and academic environment. Thus, APC undermines SS not merely because students work later, but because delay disrupts perceived competence, engagement quality, flow, and positive learning appraisals. Structural models in higher education consistently show that greater APC predicts lower academic or study satisfaction directly and through core personal determinants. Among Chinese undergraduates, APC exerted a significant direct negative effect on academic satisfaction and an additional indirect effect via reduced academic self-efficacy, indicating that procrastination depletes a central personal resource underpinning satisfaction (Tian et al., 2024). Converging evidence from Türkiye shows that procrastination lowers both personal satisfaction and satisfaction with the academic environment, with diminished flow experiences mediating this link (Öztekin et al., 2025). Cross-sectional and longitudinal work reinforce this pattern: in a large Peruvian sample, emotional exhaustion increased procrastination and reduced satisfaction, with a strongly negative path from procrastination to satisfaction (Carranza Esteban et al., 2023), while a multi-semester German study found that higher procrastination co-occurs with greater study dissatisfaction and dropout intentions (Lindner et al., 2023). Motivationally, fear of failure reduces academic

satisfaction partly because it promotes procrastination as a short-term mood-repair strategy at the cost of poorer academic appraisals (Duru et al., 2024). Collectively, these arguments support:

H3: Academic Procrastination has a negative effect on Student Satisfaction.

2.5 The relationship between Technostress (TS) and Student Satisfaction (SS)

SCT also allows for a direct environmental effect from TS to SS because digital strain can immediately reduce perceived control, learning quality, and emotional comfort in technology-mediated courses. When students experience overload, complexity, uncertainty, or intrusion from educational technologies, they may evaluate their learning environment less favourably even before considering specific procrastination behaviour. TS arises when technology-related demands exceed students' coping resources, impairing attention, emotion regulation, and perceived control in learning. These stressors erode the quality of students' learning experiences and the judgments they form about their courses. Structural models with UK undergraduates show that TS is a significant negative predictor of student satisfaction and fully mediates the impact of person-environment misfit on satisfaction, identifying TS as a proximal mechanism that depresses how students feel about their studies (Liang et al., 2024). Evidence from Malaysia likewise reports an inverse TS-SS association in online learning, with gender as a boundary condition, highlighting both the robustness of the negative link and the relevance of subgroup differences (Abd Aziz et al., 2024). Mechanistically, TS lowers perceived quality of online learning and heightens anxiety, both established antecedents of lower satisfaction; instructor and institutional support can buffer these effects, clarifying how learning environments may mitigate satisfaction costs of TS (Saleem et al., 2024). Studies that differentiate challenge from hindrance techno-stressors find that hindrance stressors are negatively related to SS, while recognising that not all technology demands are equally detrimental (Lallmahomed, 2025). Work grounded in the expectation-confirmation model further shows that TS can reduce satisfaction indirectly by undermining perceived usefulness and related cognitions (Wang & Yu, 2024). Because prior evidence is not uniform, this direct-effect hypothesis is treated as a theoretically plausible baseline test rather than as the only expected pathway. If the direct path becomes weak after APC is modelled, such a finding would be theoretically meaningful as evidence that self-regulatory disruption carries the effect of TS on SS. Accordingly, we test:

H4: Technostress has a negative effect on Student Satisfaction.

2.6 The relationship between Cyberloafing (CL) and Student Satisfaction (SS)

From a self-regulation and motivational perspective, CL may directly reduce SS because off-task digital activity displaces goal-directed attention, weakens cognitive engagement, and heightens psychological

detachment, thereby eroding the conditions under which satisfaction emerges. At the same time, CL is not assumed to have a uniformly direct effect on SS because brief off-task use may sometimes be experienced as a micro-break and may not damage satisfaction unless it develops into persistent academic delay. This distinction responds to the mixed evidence in the literature and clarifies why the model tests both a direct CL-SS path and an indirect path through APC. Recent structural work with undergraduates shows that social cyberloafing is negatively associated with learning satisfaction, and that this adverse effect is attenuated among students with stronger self-regulation, underscoring a self-control pathway through which off-task behaviour undermines satisfaction (Agrawal & Krishna, 2025). Process evidence indicates that CL reduces cognitive engagement and increases psychological detachment during class, two proximal antecedents of satisfaction with the learning experience (Levkov & Kitanovikj, 2024). Large-scale modelling of online course disengagement further positions CL and SS as concurrent drivers of disengagement, suggesting that off-task digital behaviour coexists with weakened satisfaction and deteriorated perceived course value (Mazman Akar, 2024). Multigroup analyses with Gen Z students show that permissive norms toward mobile CL elevate psychological detachment and depress cognitive engagement, aligning with the expectation that CL degrades the experiential foundations of satisfaction (Mihelič et al., 2023). Accordingly, we test the following direct-effect hypothesis while recognising that APC may account for this relationship more fully:

H5: Cyberloafing has a negative effect on Student Satisfaction.

2.7 Academic Procrastination (APC) as a Mediator

The mediation hypotheses specify the core theoretical mechanism of the model. In technology-intensive courses, TS functions as an environmental strain that diminishes attentional control, self-efficacy, and self-regulatory resources, fostering avoidance-oriented regulation that manifests as APC. Evidence in higher education shows that techno-overload is positively linked to procrastination and helps transmit the effect of low academic self-efficacy onto greater delay behaviour, indicating that technology-related strain nurtures procrastinatory tendencies (Grogan & Wipawayangkool, 2025). Applied settings likewise document a positive effect of TS on procrastination (Sheikh & Zahur, 2024). Once procrastination escalates, effort is compressed, flow and perceived competence deteriorate, and negative affect rises, depressing students' evaluative judgments of their study experience. Recent structural models show that APC is negatively associated with academic or study satisfaction and that personal resources such as academic self-efficacy or emotion regulation mediate this inverse link (Tian et al., 2024; Duru et al., 2024; Carranza Esteban et al., 2023). In parallel, TS reduces perceived quality of online learning and is implicated in lower SS, placing TS on the same evaluative pathway that culminates in satisfaction judgments (Saleem et al., 2024; Liang et al., 2024). Together, these arguments suggest a mediated process in which TS increases APC, while APC lowers SS. If the direct TS-SS path becomes non-significant after APC is included, this would support a full mediation interpretation rather than a failed theoretical relationship. Therefore, we posit:

H6: Academic Procrastination mediates the relationship between Technostress and Student Satisfaction, resulting in a negative indirect effect.

The same mediation logic applies to CL. In technology-rich classes, CL constitutes off-task digital activity that diverts attention from focal learning, lowers cognitive engagement, and heightens psychological detachment, thereby deteriorating the experiential basis of SS. Structural evidence shows that higher CL is associated with lower cognitive engagement and greater psychological detachment during class (Levkov & Kitanovikj, 2024). CL is also embedded in a broader self-regulatory deficit that promotes delay behaviour; bootstrapped models document a positive association between CL and APC, indicating that off-task digital use coexists with postponement of academic tasks (Güleç & Yıldız, 2024). APC then functions as a proximal mechanism that depresses satisfaction by compressing effort, eroding perceived competence, and disrupting positive learning appraisals. Undergraduate samples show a significant negative association between APC and academic satisfaction, with self-efficacy or flow experiences explaining how delay translates into lower satisfaction (Tian et al., 2024; Öztekin et al., 2025). Consistent with these pathways, studies report a direct adverse link from CL to learning satisfaction in online learning, moderated by self-regulation, situating CL on the same evaluative route that ends in satisfaction judgments (Agrawal & Krishna, 2025). Thus, CL is expected to undermine satisfaction primarily when it becomes a self-regulatory problem expressed as APC. Synthesising these strands yields the prediction that CL increases APC, while APC reduces SS, generating a negative indirect effect. Accordingly, we posit:

H7: Academic Procrastination mediates the relationship between Cyberloafing and Student Satisfaction, resulting in a negative indirect effect.

2.8 Social Pressure (SP) as Moderator

SP is theorised to intensify the evaluative costs of delay because procrastination creates a discrepancy between expected and actual academic behaviour. Within SCT, SP functions as an environmental influence that shapes self-standards, outcome expectations, and self-evaluative reactions. When students procrastinate under low SP, delay may remain a private self-regulatory difficulty. Under high SP, however, the same delay becomes socially evaluative because it is interpreted against expectations from peers, family, lecturers, or significant others. When students procrastinate, effort is compressed, perceived competence deteriorates, and affect becomes more negative, which already lowers academic or study satisfaction; multi-site structural evidence documents a direct negative path from APC to satisfaction, with self-efficacy or emotion regulation explaining this link (Tian et al., 2024; Duru et al., 2024; Carranza Esteban et al., 2023).

Additional theoretical perspectives clarify why SP specifically moderates the APC-SS relationship. Social comparison theory suggests that high SP makes students compare their delayed progress with perceived standards or peers' performance, which heightens shame, fear of negative evaluation, and self-criticism when procrastination occurs (Festinger, 1954). Expectancy theory and expectation-

violation theory suggest that strong expectations raise the perceived importance of academic success and make procrastination feel like a violation of expected achievement, thereby intensifying dissatisfaction (Vroom, 1964; Burgoon, 1993). Self-determination theory further indicates that high external pressure can shift motivation toward controlled regulation and undermine autonomy and competence, so procrastination is experienced not only as inefficient behaviour but also as a failure to meet imposed standards (Deci & Ryan, 2000). Empirical work in higher education shows that peer-level norms and expectations strongly shape students' psychological reactions and classroom functioning; among Gen Z students, subjective norms are tied to disengagement-related outcomes, underscoring the power of proximal normative climates for students' evaluations of learning (Mihelič et al., 2023). Cross-cultural evidence further demonstrates that societal norms magnify psychological consequences of individual beliefs and behaviours, supporting a moderation logic in which normative pressure amplifies the effects of proximal determinants on well-being (Lou & Li, 2023). Peer pressure has also been linked to increased psychological distress among university students, indicating that strong social demands intensify negative affective responses to academic difficulties (Li et al., 2023). Taken together, these arguments indicate that the negative association between APC and SS will be more pronounced under higher SP, which justifies:

H8: Social Pressure strengthens the negative effect of Academic Procrastination on Student Satisfaction.

Figure 1 summarises the proposed conditional self-regulation model. TS and CL are specified as dual antecedents that originate from different aspects of technology-rich learning. TS represents digitally mediated environmental strain, while CL represents digitally enabled behavioural diversion. Both are expected to increase APC because each weakens students' ability to initiate, sustain, and complete academic tasks. APC is then expected to reduce SS by lowering perceived competence, flow, and positive learning appraisal. The direct paths from TS and CL to SS are retained to test whether digital strain and off-task digital behaviour have residual effects beyond APC, while the mediation paths test whether APC provides the central explanatory bridge. SP is placed on the APC-SS path because it does not simply create procrastination; rather, it changes the meaning and emotional consequences of procrastination by making delay more socially evaluative. In this way, the figure should be read not as a set of isolated associations, but as a moderated mediation model in which digital demands and distractions influence satisfaction through self-regulatory failure and under varying levels of normative pressure.

The research model framework of this research shown in Figure 1:

INSERT FIGURE 1

METHODOLOGY

3.1. Research Subjects and Sampling Techniques

This quantitative survey tested the proposed model and hypotheses using structured numerical analysis (Fischer et al., 2023). A cross-sectional design was selected because it enabled the simultaneous assessment of technostress, cyberloafing, academic procrastination, social pressure, and student satisfaction in a large higher-education sample. However, the design also imposes an important interpretive boundary. Although the proposed model specifies directional relationships that are theoretically derived, the data were collected at one point in time; therefore, the findings should be interpreted as model-based statistical associations rather than evidence of causal effects or temporal ordering.

Between August 2024 and April 2025, data were collected from higher-education students at multiple universities in East and Central Java through convenience sampling, which offers cost-effective access to large, heterogeneous, and geographically dispersed student populations (Sarker & AL-Muaalemi, 2022). This approach was used because Indonesia's student population exceeds ten million, which renders probability sampling logistically prohibitive in the present project (Ministry of Higher Education, Science, and Technology, 2024), and because East and Central Java contain a dense concentration of higher-education institutions (Basuki et al., 2022). The final sample comprised 2,111 respondents across Diploma (n = 590), Bachelor (n = 870), Master (n = 440), and Doctoral (n = 211) programmes. This sample size provides broad demographic and academic variation and adequate statistical precision for the proposed model, but it should not be interpreted as a representative cross-section of all Indonesian university students. In the revised manuscript, analytical generalisability is therefore framed cautiously as transferability within the observed study context rather than population-level representativeness (Sherman, 2024).

Recruitment followed a multi-channel procedure. After ethics approval, programme administrators and student organisation leaders distributed a standardised invitation and survey link through official communication channels and academic WhatsApp groups. Early participants were invited to forward the link within and across universities, creating a snowball extension within the convenience design. This strategy increased sample reach, but it may also have introduced self-selection and network-based bias. Students who were more active in digital communication channels, more connected to student organisations, more willing to complete online surveys, or more comfortable with technology may have been more likely to participate. Conversely, students with limited internet access, weaker institutional connectedness, lower digital engagement, or stronger disengagement from academic networks may have been underrepresented. A more structured non-probability strategy, such as quota sampling proportional to institutional type, degree level, gender, and student population size, would have strengthened representativeness. Because such population-level sampling frames were not available for the present study, the sampling strategy is acknowledged as a limitation of the design rather than a limitation resolved by sample size alone (Sherman, 2024; Sarker & AL-Muaalemi, 2022; Wang et al., 2022). Detailed sample characteristics are reported in Table 1.

Data screening was conducted before model estimation to improve data quality and transparency. Responses were removed or excluded from the analytic dataset when they met any of the following

criteria: absence of informed consent; failure to meet the eligibility criterion of being currently enrolled at an East or Central Java higher-education institution; missing key demographic or academic information needed for sample description; duplicate or highly similar entries detected through repeated response identifiers or repeated demographic-response patterns; logically inconsistent responses; and low-quality response patterns such as straight-lining across long item blocks or invariant responses across conceptually distinct scales. When response-time information was available, unusually short completion times relative to questionnaire length were also flagged for review rather than used as the sole exclusion criterion. These procedures were intended to minimise duplicate, ineligible, or careless submissions while retaining valid variation in student responses.

Sample adequacy was established via an a priori power analysis in G*Power 3.1 (Faul et al., 2009), following current PLS-SEM recommendations (Hair et al., 2021; Ghasemy et al., 2020). Assuming multiple regression with a small effect size (Cohen's $f^2 = 0.02$; Cohen, 1988), $\alpha = 0.05$, desired power of 0.95, and the most parameter-rich relation involving approximately 5 to 6 predictors, the required N is approximately 550 to 650; for a medium effect ($f^2 = 0.15$), the threshold is approximately 90 to 100. The realised sample of 2,111 therefore comfortably exceeds conservative power benchmarks and provides sufficient sensitivity to detect small direct, mediating, and interaction effects in the proposed model. Nevertheless, statistical power addresses precision and error probability, not sampling representativeness. Thus, the large sample strengthens the stability of parameter estimates but does not eliminate the limitations associated with convenience and snowball sampling.

INSERT TABLE 1

3.2. Research Instruments

Technostress (TS), defined as technology-induced strain when digital demands exceed users' coping resources and reduce perceived control and study quality, was measured with five reflective items adapted from Alvarez-Risco et al. (2021). Cyberloafing (CL), defined as off-task non-academic internet use during study or class, was assessed with the 30-item student Cyberloafing Scale by Akbulut et al. (2016). The scale comprises five first-order facets, namely Sharing, Shopping, Real-Time Updating, Accessing Online Content, and Gaming/Gambling, rated on frequency-type Likert anchors. Academic procrastination (APC), the intentional delay of academic tasks despite anticipated negative consequences, was measured with Yockey's (2016) five-item short APC Scale, a unidimensional measure suitable for mediation and moderation models. Student satisfaction (SS), students' evaluations of instructional quality, organisation, support, and overall fulfilment, was measured with five reflective items adapted from Pedro et al. (2023). Social pressure (SP), perceived normative expectations from significant others regarding study success and performance standards, was captured with five reflective items adapted from the academic social pressure dimension of the Academic Expectations Questionnaire short form (Casanova et al., 2019). All constructs were specified as reflective latent

variables and rated on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree); full item wordings and anchors are reported in Table 2 (Aldhi et al., 2025).

The aggregation of the 30-item cyberloafing scale was handled carefully because the instrument contains five theoretically meaningful subdimensions. The main structural model used a global CL construct because the study's hypotheses concerned overall off-task digital behaviour as a general self-regulatory diversion in technology-rich learning, rather than the distinct effects of each cyberloafing facet. This aggregation also reduced model complexity and avoided inflating the number of hypothesis tests in a moderated mediation framework. At the same time, the five subdimensions were retained in the measurement evaluation to verify that the global construct was psychometrically coherent. Reliability and validity indicators were therefore assessed at both the global and facet levels, and the interpretation acknowledges that specific cyberloafing activities may show differential effects on procrastination and satisfaction. The revised manuscript consequently treats the global CL score as theoretically appropriate for the focal model while recognising the value of future facet-level analyses.

The instruments were adapted to Indonesian using a standard back-translation procedure (Behr, 2017). A bilingual scholar in psychology and educational measurement produced the initial Indonesian version (Sari et al., 2019), a second bilingual expert blind to the original prepared an independent English back-translation (Baldacchino & Buhagiar, 2003), and discrepancies were resolved through joint review to ensure semantic and linguistic equivalence (Ramadhani et al., 2025). A pilot with university students ($n = 30$) assessed readability, contextual appropriateness, and item-level comprehension (Lesaux et al., 2010), after which distributional properties, reliability, and validity were examined in the measurement model before estimating structural paths.

Data were collected via an online questionnaire hosted on Google Forms, selected for its accessibility and efficiency in reaching geographically dispersed respondents (Van Selin & Jankowski, 2006). Before accessing the questionnaire, participants viewed an information sheet and provided written informed consent. Participation was voluntary, no personally identifying information was requested, and responses were anonymous. The final analytic sample of 2,111 Diploma, Bachelor, Master, and Doctoral students provided sufficient heterogeneity for robust model estimation, which was conducted in SmartPLS 4.1.0.9, an appropriate platform for complex structural models involving mediation and moderation (Boldureanu et al., 2025).

Given the exclusive reliance on self-reports, the study anticipated potential bias from social desirability, recall, and same-source inflation and therefore applied complementary procedural and statistical remedies for common method bias. Procedurally, the survey guaranteed anonymity by omitting personal identifiers to limit social desirability (McNeeley, 2012), used clear and standardised instructions, separated constructs in the questionnaire flow, and randomised item order where feasible to mitigate consistency motifs and item-context effects (Podsakoff et al., 2003). The broad recruitment of students from multiple universities and degree levels in East and Central Java was also intended to reduce dependence on a single narrow respondent subgroup (Wang et al., 2022).

Statistically, the revised analysis did not rely solely on Harman's single-factor test. Harman's single-factor test was retained as an initial diagnostic, but it was supplemented with construct-level and full-collinearity variance inflation factor checks, with values below critical cutoffs interpreted as evidence against severe common method inflation (Kock, 2017). In addition, a CFA-based common method factor sensitivity assessment was specified by comparing the substantive measurement model with an alternative model that included a general method factor loading on the indicators. This supplementary assessment was used to examine whether indicator loadings and substantive structural paths changed materially after accounting for a potential common source factor. Because the original questionnaire did not include a theoretically neutral marker variable, a marker-variable test could not be implemented without adding an unplanned construct post hoc. These procedures reduce, but cannot fully eliminate, the possibility of common method variance; therefore, the results are interpreted with appropriate caution.

3.3. Data Analysis Technique

Data were analysed in two phases using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS version 4.1.0.9. PLS-SEM is suitable for complex models with multiple latent constructs, mediation and moderation, and for moderate to large non-normal samples such as the present dataset of 2,111 students from several universities in East and Central Java (Sarstedt et al., 2020; Ghasemy et al., 2020). The measurement model was evaluated via factor loadings ($\geq .70$), Average Variance Extracted ($AVE \geq 0.50$, with loadings generally above .65), and Composite Reliability and Cronbach's alpha (both $> .70$) to ensure indicator reliability, convergent validity, and internal consistency (Alt et al., 2022; She et al., 2023; Rathi et al., 2025). Discriminant validity was assessed using the Fornell-Larcker criterion, cross-loadings, and HTMT: for all constructs, the square root of AVE was expected to exceed inter-construct correlations, items were expected to load higher on their own construct than on others, and HTMT values were expected to remain below recommended thresholds (Henseler et al., 2015; Ali et al., 2018).

After confirming the measurement model, the structural model was estimated to test the hypothesised relations among latent variables (Aldhi et al., 2024). Standardised path coefficients (β), coefficients of determination (R^2), and associated t and p values were reported (Sutrisno et al., 2024). The sign and magnitude of β indicate direction and effect size, and hypotheses were evaluated using two-tailed tests at $\alpha = 0.05$ (Truong et al., 2021). Because the research design is cross-sectional, the path coefficients, mediation estimates, and moderation effects are interpreted as theory-guided conditional associations rather than causal effects. Terms such as effect, influence, mediation, and moderation are used in the statistical modelling sense and do not imply experimental or longitudinal causal identification.

R^2 values were interpreted in line with recommended benchmarks, where values around 0.75, 0.50, and 0.25 indicate substantial, moderate, and weak explanatory power, respectively (Hair et al., 2021). However, student satisfaction is a broad and multidetermined outcome shaped by many factors beyond

the present model, including perceived teaching quality, institutional support, sense of belonging, academic achievement, well-being, and campus climate. Therefore, the model was not positioned as a comprehensive account of student satisfaction, but as a focused and partial explanation of a digital self-regulation pathway linking technostress, cyberloafing, procrastination, social pressure, and satisfaction. In this sense, a modest R^2 for SS was interpreted as evidence that the model captures a theoretically meaningful but limited component of satisfaction, whereas the stronger R^2 for APC indicates that the predictors are more directly suited to explaining self-regulatory behaviour.

Explanatory results were complemented with three prediction-oriented procedures. Blindfolding was used to compute Stone-Geisser's cross-validated redundancy (Q^2) for each endogenous construct, where positive Q^2 values indicate predictive relevance (Hair et al., 2017). Importance-Performance Map Analysis (IPMA) contrasted each antecedent's total effect on the target construct with its rescaled performance score to identify high-leverage constructs for managerial or pedagogical action (Ringle & Sarstedt, 2016). PLSpredict evaluated out-of-sample predictive power via holdout or k-fold cross-validation, generating case-level predictions, Q^2_{predict} , and error metrics such as MAE and RMSE benchmarked against a linear model; positive Q^2_{predict} values and lower PLS-SEM errors relative to the benchmark indicated meaningful predictive utility (Shmueli et al., 2019). These predictive statistics were interpreted as complements to explanatory analysis rather than as evidence that the model fully predicts all determinants of student satisfaction.

Results

4.1. Common Method Bias Test Results

To assess potential common method bias (CMB) from the self-report survey, Harman's single-factor test and full collinearity VIF analysis were conducted (Podsakoff et al., 2003; Kock, 2017). An exploratory factor analysis (Principal Axis Factoring) of all 48 items showed that the first unrotated factor explained 36.519% of the total variance, below the 50% benchmark for serious CMB, and that five factors with eigenvalues greater than 1 together accounted for 55.115% of the variance, indicating that no single factor dominated the solution. In the PLS-SEM inner model, full collinearity VIFs for all constructs ranged from 1.000 to 1.493, well below the conservative cut-off of 3.3 (Kock, 2017). Taken together, these findings suggest that common method variance and multicollinearity do not pose a serious threat to the validity of the structural relationships in this study.

4.2. Measurement Model Test Results

The measurement model assessment (Figure 2; Table 2) indicates satisfactory convergent validity and internal consistency for all latent constructs. For technostress (TS), all indicators load above 0.73, with Cronbach's alpha of 0.721, composite reliability of 0.827, and AVE of 0.544. The multidimensional cyberloafing (CL) construct also shows strong psychometric properties at both the global and facet

levels: the 30-item scale yields alpha of 0.971, composite reliability of 0.973, and AVE of 0.543, while the five subdimensions (Sharing, Shopping, Real-Time Updating, Accessing Online Content, Gaming/Gambling) all exhibit high loadings (generally > 0.76), alpha between 0.845 and 0.915, composite reliabilities from 0.896 to 0.930, and AVE values above 0.59. Academic procrastination (APC) displays loadings between 0.722 and 0.762, with alpha of 0.798, composite reliability of 0.861, and AVE of 0.553. Student satisfaction (SS) has loadings between 0.696 and 0.755, alpha of 0.786, composite reliability of 0.853, and AVE of 0.537. Social pressure (SP) yields loadings from 0.695 to 0.846, alpha of 0.792, composite reliability of 0.856, and AVE of 0.599. Overall, all outer loadings exceed 0.69, composite reliabilities are well above 0.70, and AVE values are above 0.50, confirming robust convergent validity and reliability.

INSERT FIGURE 2

INSERT TABLE 2.

Discriminant validity was examined using the Fornell–Larcker criterion (Table 3). For each construct, the square root of AVE (APC = 0.743; CL = 0.737; SP = 0.774; SS = 0.733; TS = 0.738) exceeded its correlations with all other constructs, indicating that each latent variable shares more variance with its own indicators than with any other construct. The highest inter-construct correlation ($|r| = 0.534$ between APC and CL) remained below the corresponding AVE square roots, supporting the empirical distinctiveness of TS, CL, APC, SP, and SS.

INSERT TABLE 3

The Heterotrait–Monotrait Ratio (HTMT) provided a complementary check (Table 4). All HTMT values fell well below the conservative 0.85 threshold, with the highest estimate between APC and CL (0.606) and moderate values for TS–APC (0.423) and TS–CL (0.421). SP showed very low HTMT values with the other constructs (0.027–0.130), and the interaction term $SP \times APC$ was clearly distinguishable from its components (HTMT = 0.087–0.164). These results reinforce the Fornell–Larcker findings and confirm that the constructs and their interaction represent empirically distinct concepts, supporting the adequacy of the measurement model for subsequent structural analyses.

INSERT TABLE 4

4.3. Structural Equation Test Results

The structural relationships among TS, CL, APC, SP, and SS were estimated using PLS-SEM. As shown in Table 5 and Figure 3, TS and CL were positively associated with APC (H1: $\beta = 0.152$, $t = 4.659$, $p < 0.001$; H2: $\beta = 0.480$, $t = 12.671$, $p < 0.001$), with CL showing the stronger path coefficient. APC was negatively associated with SS (H3: $\beta = -0.284$, $t = 10.945$, $p < 0.001$). By contrast, the direct paths from TS and CL to SS were not statistically significant (H4: $\beta = -0.040$, $t = 1.528$, $p = 0.126$; H5: $\beta = -0.048$, $t = 1.883$, $p = 0.060$). These nonsignificant direct paths suggest that technostress and cyberloafing do not have

meaningful residual direct associations with student satisfaction after academic procrastination is included in the model.

The mediation results support a full mediation, or indirect-only mediation, interpretation. TS and CL were significantly associated with APC, and APC was significantly associated with SS, while the corresponding direct paths from TS and CL to SS were not significant. At the same time, the indirect effects of TS and CL on SS through APC were significant and negative (H6: $\beta = -0.043$, $t = 4.200$, $p < 0.001$; H7: $\beta = -0.137$, $t = 7.269$, $p < 0.001$). This pattern indicates that technostress and cyberloafing are linked to student satisfaction primarily through academic procrastination rather than through direct attitudinal pathways. Academic procrastination therefore functions as the central self-regulatory mechanism connecting digital strain and off-task digital behaviour with lower student satisfaction.

The moderation result also supported H8. The interaction between SP and APC was significantly associated with SS ($\beta = -0.097$, $t = 3.230$, $p = 0.001$), indicating that social pressure strengthens the negative relationship between academic procrastination and student satisfaction. However, the f^2 value for the interaction term was 0.010, which is below the conventional threshold for a small effect. Thus, although the moderation effect is statistically significant and theoretically meaningful, its practical magnitude is very small and should be interpreted cautiously, particularly given the large sample size.

The f^2 results further clarify the substantive magnitude of the structural paths. CL had a medium effect on APC ($f^2 = 0.291$), whereas TS had a small effect on APC ($f^2 = 0.029$). APC had a small effect on SS ($f^2 = 0.061$). In contrast, the direct paths from TS and CL to SS had negligible effect sizes ($f^2 = 0.000$ and $f^2 = 0.006$, respectively). These values reinforce the full mediation interpretation because the direct paths to SS were both statistically nonsignificant and practically negligible, whereas the indirect paths through APC were statistically significant.

The model explained 38.0% of the variance in APC ($R^2 = 0.380$), indicating meaningful explanatory power for students' academic procrastination. However, the model explained only 7.8% of the variance in SS ($R^2 = 0.078$). This relatively low R^2 indicates that the present model should be interpreted as a focused and partial explanation of student satisfaction rather than as a comprehensive model of satisfaction. Student satisfaction is a broad evaluative outcome that is likely shaped by additional academic, institutional, interpersonal, and psychological factors, including perceived teaching quality, lecturer support, institutional support, sense of belonging, academic achievement, well-being, course design, feedback quality, and campus climate. Therefore, the modest explanatory power for SS does not invalidate the proposed digital self-regulation mechanism, but it shows that TS, CL, APC, and SP capture only one specific pathway through which technology-rich learning environments may influence students' academic evaluations..

INSERT TABLE 5

INSERT FIGURE 3

Predictive relevance was examined using Stone-Geisser’s Q^2 based on the blindfolding procedure (Table 6). APC showed a positive Q^2 value of 0.205, indicating moderate predictive relevance. SS showed a smaller but positive Q^2 value of 0.040, suggesting limited but non-zero predictive relevance. The exogenous constructs, namely TS, CL, and SP, were not interpreted as prediction targets in the blindfolding procedure. These findings are consistent with the R^2 results and indicate that the model has stronger explanatory and predictive relevance for APC than for SS.

INSERT TABLE 6

Importance-Performance Map Analysis (IPMA; Table 7) was conducted using SS as the target construct. APC had the largest absolute importance value (importance = -0.284), followed by SP (importance = -0.070), CL (importance = -0.048), and TS (importance = -0.040). On the rescaled 0 to 100 performance metric, APC and SP showed relatively high performance values (90.318 and 89.991), whereas TS showed the lowest performance value (74.810). Because the focal antecedents are undesirable or pressure-related constructs and their total effects on SS are negative, high performance should be interpreted as a higher level of the problematic condition rather than as a desirable achievement. Accordingly, APC represents the most important intervention priority because it has the largest negative importance for SS and a high performance score in the sample. Reducing academic procrastination is therefore likely to provide the clearest practical route for improving student satisfaction within the present model. SP, CL, and TS may also be relevant, but their smaller importance values suggest that they should be treated as secondary intervention targets.

INSERT TABLE 7

Out-of-sample predictive power was further assessed using the PLS MV-LV Predict procedure (Table 8). At the construct level, Q^2_{predict} was 0.301 for APC, indicating moderate-to-strong predictive accuracy, whereas Q^2_{predict} was 0.010 for SS, indicating very weak predictive relevance. All item-level Q^2_{predict} values for APC indicators were positive (0.143 to 0.190), showing that the model outperformed a naive benchmark for these indicators. For SS, four indicators showed small positive Q^2_{predict} values (0.003 to 0.010), while one indicator (SS5) was slightly negative (-0.001), suggesting minimal incremental predictive utility for satisfaction. The RMSE and MAE values followed the same general pattern. Overall, the model generalises reasonably well for predicting APC, but its predictive utility for SS remains modest. This reinforces the interpretation that the model offers a partial digital self-regulation account of student satisfaction and that future research should incorporate additional determinants of satisfaction to improve explanatory and predictive performance.

INSERT TABLE 8

DISCUSSION

5.1. Digital strain, cyberloafing, and academic procrastination (Hypotheses 1 and 2 Supported)

The findings indicate that TS and CL are positively associated with APC. Because the study uses cross-sectional data, these paths are interpreted as theory-guided statistical associations rather than evidence of temporal or causal effects. Within this boundary, the results suggest that students who report higher technology-related strain and more frequent off-task digital behaviour also tend to report higher academic procrastination. The TS-APC path is small but significant, whereas the CL-APC path is stronger, indicating that behavioural diversion is more closely linked to procrastination than perceived digital strain in this sample. This pattern is consistent with the view of TS as a strain condition that can tax cognitive and emotional resources needed for timely task initiation and sustained engagement (Vallone et al., 2023; Mehmood et al., 2024). Continuous connectivity, notification overload, frequent platform changes, and complex digital tools may increase perceived burden, although the present design cannot confirm that these experiences temporally precede procrastination.

The result is also consistent with prior work linking TS to self-regulatory difficulty. TS has been shown to increase cyberslacking through deficient self-control and burnout (Li & Liu, 2022), techno-overload is positively linked to APC (Grogan & Wipawayangkool, 2025), and several TS dimensions are associated with procrastination tendencies beyond student samples (Sheikh & Zahur, 2024). Research on digital burnout further indicates that intensive technology use is associated with fatigue, reduced life satisfaction, and higher APC (Savaş et al., 2025). These findings align with contemporary conceptualisations of procrastination as a self-regulatory difficulty that emerges when goal setting, decision making, and perseverance are weakened (Elizondo et al., 2024). In this sense, TS can be understood as a contextual risk factor that is linked to procrastination through diminished self-regulatory capacity, rather than as a direct determinant of all academic outcomes.

The stronger association between CL and APC further highlights the behavioural nature of procrastination in technology-rich learning. From an SCT perspective, CL represents a learned pattern of behaviour reinforced by immediate rewards such as enjoyment, social interaction, relief from boredom, or temporary escape from demanding tasks. Repeated exposure to these short-term rewards may make off-task digital behaviour more attractive than academic work, especially when students experience weak self-monitoring or low task engagement. This interpretation is supported by evidence that higher CL is associated with weaker self-regulation and greater APC in online courses (Baturay & Toker, 2022), and with higher stress, lower self-efficacy, and weaker self-discipline in technology-enhanced instruction (Akbulut et al., 2023). CL is also positively related to APC and negatively related to engagement, with time-management difficulties mediating this link (Sari & Nayir, 2023). Thus, the present findings are best understood as evidence that CL is a proximal behavioural correlate of procrastination, especially when it disrupts goal setting, time management, and sustained attention, which are core self-regulatory processes in SCT.

5.2 Academic procrastination and student satisfaction (Hypothesis 3 Supported)

APC is negatively associated with SS, supporting H3 and positioning procrastination as the most influential predictor of satisfaction in the model. This interpretation should be balanced with the modest

explanatory power for SS. The model explains satisfaction only partially, but within this specific digital self-regulation pathway, students who report greater academic delay also tend to report lower satisfaction. Theoretically, procrastination may undermine satisfaction because repeated delay is associated with time pressure, superficial study strategies, missed deadlines, lower perceived mastery, and negative self-evaluation. Through an SCT lens, these experiences may be associated with weaker academic self-efficacy and less favourable outcome expectations, which may help explain why students with higher procrastination tend to appraise their courses and wider academic environment less favourably.

This interpretation is consistent with contemporary empirical work. APC is negatively related to SS in large college samples (Bhat & Jan, 2023; Kifayat et al., 2024) and predicts lower academic satisfaction partly through reduced self-efficacy (Tian et al., 2024). Studies embedding APC in broader well-being models show that procrastination is associated with lower academic and life satisfaction (Topaloğlu et al., 2023; Demir & Kuşcu Karatepe, 2025). APC also mediates the relationship between Facebook addiction and academic satisfaction (Ho et al., 2024), indicating that problematic technology use is linked to satisfaction largely when it is accompanied by academic delay. In the present study, this supports the interpretation of APC as a central self-regulatory bridge between digital learning difficulties and students' satisfaction judgments.

5.3 Interpreting the non-significant direct paths from technostress and cyberloafing to student satisfaction (Hypotheses 4 and 5 Not Supported)

The direct TS-SS path is negative but small and non-significant, so H4 is not supported. Rather than treating this as a failed relationship, the result is theoretically informative because it suggests that TS is not directly associated with global satisfaction once APC, CL, and SP are considered. Student satisfaction is a broad evaluative outcome that reflects multiple academic, institutional, interpersonal, and psychological experiences. Technology-related strain may therefore not be sufficient by itself to alter satisfaction unless it affects students' capacity to regulate academic work. This is consistent with the mediation pattern observed in the study, where TS is associated with APC and APC is associated with SS.

A deeper theoretical explanation is that TS may be appraised differently across students and learning contexts. Some students may interpret digital demands as hindrances, while others may experience them as manageable challenges if they possess adequate technology self-efficacy, coping strategies, and institutional support. Prior studies show that technostressors such as techno-complexity and techno-insecurity are related to SS and performance in online learning (Abd Aziz et al., 2023), and that TS is associated with perceived quality of online learning unless buffered by instructor and institutional support (Saleem et al., 2024). Challenge and hindrance perspectives further show that some technostressors can coexist with engagement and satisfaction, whereas hindrance techno-stressors are more likely to be associated with burnout and dissatisfaction (Lallmahomed, 2025). Related evidence indicates that self-efficacy and social support shape TS and its emotional consequences, and that some

TS dimensions may have protective or facilitating properties (Cazan et al., 2024; Vallone et al., 2023). In line with Efiliti et al. (2024), who found that global TS did not significantly predict life satisfaction, the present findings suggest that the direct association between TS and SS may become weak when self-regulatory pathways are explicitly included. Thus, the absence of a significant direct TS-SS path can be interpreted as evidence that technostress is not necessarily translated into dissatisfaction at the attitudinal level unless it is accompanied by impaired self-regulation, reduced perceived competence, or persistent academic delay.

The direct CL-SS path is also small and non-significant, so H5 is not supported. This finding should be interpreted by distinguishing occasional off-task behaviour from chronic cyberloafing. Occasional cyberloafing may occur as a brief micro-break, a moment of mood repair, or a low-intensity recovery strategy, and it may not necessarily alter students' overall satisfaction when it remains controlled and does not interfere with academic task completion. Chronic cyberloafing, by contrast, involves frequent or habitual diversion from academic work and is more likely to be linked to negative academic outcomes when it develops into persistent procrastination. Existing studies support this conditional view. In online learning, social CL is negatively associated with learning satisfaction, but this association is attenuated among students with high self-regulation (Agrawal & Krishna, 2025). CL's relationship with meaning in life is partly mediated by anxiety and buffered by psychological flexibility (Li et al., 2022). Research in organisational and healthcare settings also documents neutral or even beneficial associations between cyberloafing and creativity, recovery, or well-being (Kwala & Agoyi, 2024; Aciksoz et al., 2024). Work on the determinants of CL further emphasises self-regulation and self-efficacy (Bibi et al., 2025). Accordingly, the non-significant CL-SS path suggests that cyberloafing should not be treated as uniformly harmful. Its implications for satisfaction may depend on intensity, frequency, and self-regulatory consequences. Occasional and controlled cyberloafing may have minimal implications for global satisfaction, whereas chronic cyberloafing is more likely to become problematic when it develops into persistent academic procrastination.

5.4 Academic procrastination as an indirect-only mediator (Hypotheses 6 and 7 Supported)

The mediation analyses support H6 and H7 and indicate an indirect-only, or full mediation, pattern. TS and CL are significantly associated with APC, and APC is significantly associated with SS, whereas the direct paths from TS and CL to SS are not significant. Because the data are cross-sectional, this should be interpreted as statistical mediation within a theory-guided model, not as proof of temporal causality. Nevertheless, the pattern clarifies the central process proposed in the study: digital strain and off-task online behaviour are linked to lower satisfaction mainly when they are accompanied by academic procrastination.

For TS, the results suggest that technostress is associated with satisfaction mainly through its connection with procrastination. Prior work shows that TS is linked to cyberslacking through deficient self-control and burnout (Li & Liu, 2022), and that digital burnout is associated with APC and lower life satisfaction (Savaş, 2025). For CL, the indirect association through APC is larger than the corresponding

TS pathway, indicating that CL is a more prominent behavioural route in the present model. Studies among Indonesian and international students show that CL is significantly associated with APC (Margaretha et al., 2022; Güleç & Yıldız, 2024) and is intertwined with broader self-regulatory problems. More broadly, recent research documents that APC mediates the relationships of Facebook addiction (Ho et al., 2024), fear of failure and emotion regulation difficulties (Duru et al., 2024), academic stress (Akbaba, 2024), and reduced flow (Öztekin, 2025) with satisfaction and well-being. The present findings extend this literature by supporting the role of APC as a common self-regulatory pathway.

5.5 Social pressure as a boundary condition (Hypothesis 8 Supported)

The moderation analysis supports H8, indicating that the negative association between APC and SS is stronger among students reporting higher SP. As illustrated in Fig. 4, differences in SP are relatively limited when APC is low, but as procrastination increases, satisfaction declines more steeply among students who perceive higher SP. This means that procrastination is associated with lower SS more strongly under conditions of salient expectations from significant others. However, the practical magnitude of this interaction should not be overstated. The f^2 value for the interaction term is 0.010, indicating a very small moderation effect. Thus, SP should be interpreted as a subtle but theoretically meaningful boundary condition rather than as a dominant determinant of student satisfaction.

INSERT FIGURE 4

This pattern is consistent with SCT because SP functions as an environmental influence that shapes self-standards, outcome expectations, and self-evaluative reactions. Students who procrastinate while experiencing strong external expectations may perceive a sharper discrepancy between expected and actual behaviour, which can intensify self-blame, guilt, fear of negative evaluation, and stress. This interpretation aligns with evidence that procrastination is associated with elevated stress in evaluative contexts (Sirois, 2023) and moderately predicts depression, anxiety, and stress, especially among university students (Nie, 2025). High SP may therefore make procrastination more socially evaluative, although the observed interaction remains small.

Prior research supports SP as a contextual amplifier. Among Chinese medical students, peer pressure moderated the relationship between career calling and APC, with constructive norms reducing procrastination and misaligned norms increasing it (Wang et al., 2023). In the present model, a related mechanism appears at the evaluative stage: SP does not primarily explain the formation of procrastination, but it is associated with stronger negative consequences of procrastination for satisfaction. High-pressure environments may make procrastination more salient as a perceived failure to meet expectations, especially when evaluative anxiety and social comparison tendencies are high (Vasiou et al., 2025). Evidence from adolescents likewise shows that high academic SP is associated with stress, whereas family support and self-regulated learning foster resilience (Suud et al., 2024). This moderating pattern is also consistent with findings that APC is associated with lower academic satisfaction (Tian et al., 2024; Kifayat et al., 2024; Ho et al., 2024). Thus, the present study extends prior

work by showing that the APC-SS association is contingent on normative context, while also acknowledging that the incremental effect of this contingency is modest.

5.6 Integrative interpretation and contextual boundaries

Taken together, the findings provide a focused digital self-regulation account of student satisfaction in the Indonesian higher education context examined in this study. The main theoretical contribution is not that technostress and cyberloafing directly lower satisfaction, but that their links with satisfaction are mediated by academic procrastination. This distinction is important because it shifts attention from technology exposure itself to the self-regulatory consequences of technology-rich learning. In other words, students may tolerate digital demands or occasional off-task online behaviour without substantial dissatisfaction, but satisfaction becomes more vulnerable when these experiences are associated with chronic delay, weakened task management, and negative self-evaluation.

At the same time, the discussion should be bounded by the model's explanatory scope and research context. The model explains APC more strongly than SS, and the low explained variance for SS indicates that satisfaction is shaped by additional determinants not included here, such as teaching quality, lecturer feedback, institutional support, sense of belonging, academic achievement, well-being, course design, and campus climate. Therefore, the findings should not be generalised as a comprehensive explanation of satisfaction across all higher education systems. Rather, they offer a partial, context-sensitive account of how digital strain, cyberloafing, academic procrastination, and social pressure are statistically connected among students in East and Central Java. Future studies using longitudinal, experimental, or multi-wave designs are needed to test temporal ordering and to examine whether the same indirect and moderated patterns hold in other cultural and institutional settings.

Theoretically, these findings refine rather than merely confirm the application of SCT in technology-rich higher education. The nonsignificant direct paths from TS and CL to SS indicate that digital strain and off-task online behaviour should not be assumed to translate automatically into lower satisfaction. Instead, their relevance for satisfaction appears to depend on whether they are associated with self-regulatory disruption, particularly APC. This extends SCT by showing that behavioural self-regulation is not only one component of the triadic system, but also the mechanism through which environmental digital demands and digitally enabled behaviours become evaluatively meaningful for students. The model therefore shifts the theoretical emphasis from technology exposure itself to the self-regulatory consequences of technology use.

CONCLUSIONS

This study examined the relationships among technostress, cyberloafing, academic procrastination, social pressure, and student satisfaction in technology-rich higher education using a moderated mediation model. The findings indicate that technostress and cyberloafing are positively associated with academic procrastination, with cyberloafing showing the stronger association. Academic procrastination is negatively associated with student satisfaction and functions as the central self-regulatory

mechanism through which digital strain and off-task digital behaviour are statistically linked to lower satisfaction. The direct paths from technostress and cyberloafing to student satisfaction are not significant, whereas their indirect paths through academic procrastination are significant, supporting an indirect-only or full mediation interpretation.

The findings also show that social pressure strengthens the negative association between academic procrastination and student satisfaction, although the moderation effect is very small in practical magnitude. Therefore, social pressure should be interpreted as a subtle boundary condition rather than a dominant determinant of satisfaction. Overall, the study suggests that student satisfaction in technology-rich learning environments is not shaped simply by exposure to digital demands or off-task online behaviour. Rather, satisfaction becomes more vulnerable when these experiences are associated with persistent academic procrastination and when procrastination occurs under strong normative expectations. Given the cross-sectional design and the modest explanatory power for student satisfaction, the findings should be interpreted as theory-guided statistical associations and as a focused digital self-regulation account rather than as a comprehensive explanation of student satisfaction.

THEORETICAL IMPLICATION

Theoretically, this study refines the application of Social Cognitive Theory in technology-rich higher education by specifying a conditional self-regulation mechanism. The novelty of the study lies not only in combining technostress and cyberloafing, but in showing that these two digital experiences represent different but complementary antecedents of academic procrastination. Technostress reflects technology-related environmental strain, while cyberloafing reflects digitally enabled behavioural diversion. Both are linked to student satisfaction primarily through academic procrastination, which positions procrastination as the key behavioural mechanism through which digital learning conditions become evaluatively meaningful for students.

This finding extends existing Social Cognitive Theory literature by clarifying that environmental and behavioural influences do not necessarily translate directly into global satisfaction. Instead, their relevance depends on whether they are associated with disruption in self-regulated academic action. The nonsignificant direct paths from technostress and cyberloafing to student satisfaction are therefore theoretically informative. They suggest that technology-related stress and digital distraction may not automatically reduce satisfaction once students' procrastination is considered. This helps explain why prior studies have reported mixed findings regarding the effects of technostress and cyberloafing on student outcomes.

The study also extends the theory by incorporating social pressure as a normative boundary condition. Social pressure does not replace self-regulation as the central mechanism, but it shapes the evaluative consequences of procrastination. When students experience stronger expectations from significant others, academic delay may be interpreted more negatively and may be associated with lower

satisfaction. However, because the moderation effect is very small, the theoretical contribution should be understood as identifying a contextual qualifier rather than proposing social pressure as a major explanatory factor. In this way, the study advances a more precise and conditional application of Social Cognitive Theory, where digital strain, digital diversion, self-regulatory failure, and normative pressure jointly explain one specific pathway to student satisfaction.

PRACTICAL IMPLICATION

The practical implications should be prioritised according to the strength and meaning of the empirical findings. The first priority is academic procrastination because it is the only construct with a significant direct association with student satisfaction and serves as the full mediating mechanism between technostress, cyberloafing, and satisfaction. Universities should therefore place self-regulation support at the centre of student success strategies. This can be implemented through structured training in academic planning, digital time management, goal setting, deadline management, and adaptive coping with online learning demands. These interventions can be embedded into first-year orientation, academic advising, counselling services, and study skills courses.

The second priority is cyberloafing because it shows the strongest association with academic procrastination. The practical response should not be limited to restricting technology use, since occasional and controlled off-task behaviour may not necessarily harm satisfaction. Instead, universities should help students distinguish between brief restorative digital breaks and chronic cyberloafing that disrupts academic tasks. Lecturers may help limit unmanaged cyberloafing by designing more active and engaging digital learning sessions, setting explicit expectations for device use, incorporating short planned breaks, and encouraging students to monitor their own online behaviour. Supportive digital self-control strategies are likely to be more productive than purely punitive restrictions.

The third priority is technostress, which has a smaller direct role in the model but remains relevant because it is associated with academic procrastination. Universities should reduce unnecessary digital strain by simplifying learning platforms, avoiding redundant digital systems, coordinating online workload and deadlines across courses, and providing timely technical and pedagogical support. Lecturers should also receive training in digital workload design so that online assignments, platform requirements, and communication expectations do not create excessive cognitive burden for students. These measures are directly linked to the finding that technostress is more consequential when it is associated with self-regulatory disruption.

The fourth priority is social pressure. Although social pressure significantly moderates the relationship between academic procrastination and student satisfaction, its effect size is very small. Therefore, universities should avoid overstating social pressure as a primary intervention target. The practical focus should be on helping lecturers, advisers, and families create high but supportive expectations. Academic expectations should be communicated in ways that encourage persistence, autonomy, and help-seeking rather than guilt, fear of failure, or excessive self-criticism. This is especially relevant in collectivist

contexts where family and peer expectations may strongly shape how students interpret academic delay.

POLICY IMPLICATIONS

The findings also have implications for higher education policy, particularly in Indonesia and other Global South contexts where digital transformation in higher education is expanding rapidly. Policy agendas for technology-intensive learning should not focus only on infrastructure, platform adoption, and digital access. They should also include student self-regulation, digital well-being, technostress management, and responsible digital behaviour as explicit quality indicators. The relatively stronger explanatory power for academic procrastination indicates that digital transformation policies need to address how students manage learning tasks in technology-rich environments, not merely whether digital tools are available.

At the institutional governance level, higher education authorities should encourage universities to develop clear standards for digital learning workload, platform integration, online communication, and student support. Fragmented platforms, overlapping deadlines, excessive notifications, and poorly coordinated digital assignments may increase technostress and create conditions in which procrastination becomes more likely. Therefore, policy frameworks should promote coordinated digital course design, platform simplification, and minimum support standards for students and lecturers. Such governance is particularly important in resource-constrained institutions where students may face unequal access to stable internet, devices, and digital learning support.

For Indonesian higher education, the findings suggest that national and institutional digital transformation initiatives should include preventive student support systems. These may include regular monitoring of technostress, cyberloafing tendencies, academic procrastination, and satisfaction; early warning systems linked to counselling and academic advising; and scalable self-regulated learning programmes that can be implemented across public and private universities. Policies should also promote lecturer development in digital pedagogy, because technology-intensive learning environments require not only technical competence but also careful management of workload, feedback, interaction, and student engagement.

For the broader Global South context, the study highlights the need for digital transformation policies that are psychologically sustainable and socially sensitive. Digital learning expansion can increase flexibility and access, but it may also create new forms of strain and distraction if not accompanied by support for self-regulation and well-being. Policymakers should therefore treat digital transformation as both a technological and developmental agenda. Effective policy should combine infrastructure investment with student-centred digital learning governance, inclusive access, academic support, and culturally appropriate communication of performance expectations. This approach can help ensure that technology-intensive higher education strengthens learning quality without unintentionally increasing procrastination, stress, or dissatisfaction.

LIMITATION & FUTURE RESEARCH DIRECTIONS

This study has several limitations that should be acknowledged when interpreting the findings. First, the use of a cross-sectional design limits the ability to establish temporal ordering and causal inference among technostress, cyberloafing, academic procrastination, social pressure, and student satisfaction. Although the proposed model specifies directional relationships based on Social Cognitive Theory and prior literature, the data were collected at a single point in time. Therefore, the observed relationships should be interpreted as theory-guided statistical associations rather than definitive evidence of causal effects. Future studies should use longitudinal, multi-wave, or panel designs to examine whether technostress and cyberloafing precede academic procrastination over time and whether procrastination subsequently contributes to changes in student satisfaction.

Second, the study relied on self-report questionnaires to measure all focal constructs. Although validated scales were used and procedural safeguards were implemented, self-report data may still be affected by social desirability, recall bias, consistency motifs, and common method variance. These concerns are particularly relevant for socially undesirable behaviours such as cyberloafing and academic procrastination, as students may underreport the frequency of off-task digital behaviour or academic delay. Future research should complement self-report measures with behavioural, observational, or trace-based indicators, such as learning analytics, platform usage logs, digital activity records, assignment submission timestamps, attendance records, or academic performance data. Combining subjective and objective indicators would provide a more robust understanding of how digital strain and off-task online behaviour relate to academic self-regulation and satisfaction.

Third, the use of convenience and snowball sampling through online distribution channels limits the representativeness of the sample. The large sample size improves statistical precision and supports the estimation of a complex PLS-SEM model, but it does not eliminate the limitations of non-probability sampling. Students who were more digitally connected, more active in academic communication channels, or more willing to complete online surveys may have been more likely to participate. Conversely, students with limited internet access, weaker institutional connectedness, or lower digital engagement may have been underrepresented. Future studies should consider more structured sampling strategies, such as stratified sampling, quota sampling by institution and academic level, or multi-stage sampling, to improve representativeness across institutional types, regions, disciplines, and student populations.

Fourth, the explained variance for student satisfaction was relatively modest. The model explained academic procrastination more strongly than student satisfaction, indicating that technostress and cyberloafing are more directly suited to explaining self-regulatory delay than global satisfaction. Student satisfaction is a broad and multidimensional outcome that is likely shaped by additional academic, institutional, interpersonal, and psychological factors not included in the present model. Future research should incorporate further predictors such as perceived teaching quality, lecturer feedback, student engagement, institutional support, sense of belonging, academic achievement, learning environment quality, digital literacy, student well-being, and campus climate. Including these variables may provide a more comprehensive account of student satisfaction in technology-rich higher education.

Fifth, the present study was conducted among students from universities in East and Central Java, Indonesia. Although this context provides valuable evidence from a Global South and collectivist higher education setting, the findings should not be generalised uncritically to other countries, institutional systems, or cultural contexts. Social pressure, digital learning conditions, cyberloafing norms, and satisfaction expectations may differ across regions and higher education systems. Future research should conduct cross-cultural and multi-country comparisons to examine whether the proposed moderated mediation model operates similarly across collectivist and individualist contexts, public and private universities, and different levels of digital infrastructure.

These limitations open several avenues for future research. Longitudinal and experimental studies would be especially valuable for clarifying the causal mechanisms implied by the model. Longitudinal research could examine reciprocal dynamics in which technostress and cyberloafing are not only associated with later procrastination, but are also shaped by prior procrastination, satisfaction, self-efficacy, and academic performance. Experimental or intervention-based studies could test whether self-regulation training, technostress reduction strategies, digital time-management programmes, or cyberloafing management interventions reduce academic procrastination and improve satisfaction. Such designs would provide stronger evidence regarding causal pathways and practical intervention points.

Future research should also examine the constructs in greater detail. Technostress and cyberloafing are multidimensional phenomena, and their subdimensions may not operate identically. For example, techno-overload, techno-complexity, and techno-invasion may have different implications for self-regulation, while social cyberloafing, entertainment use, online content access, and gaming may vary in intensity, frequency, and academic consequences. Disaggregating these dimensions would allow future studies to determine whether some forms of technostress or cyberloafing are more strongly associated with procrastination and satisfaction than others. Further mediators and moderators, such as academic self-efficacy, emotion regulation, digital literacy, psychological flexibility, social support, autonomy support, and different types of social pressure, should also be examined to clarify when and for whom digital demands translate into procrastination and lower satisfaction.

Finally, future studies should consider multi-level designs that account for class-level, programme-level, and institution-level factors. Technology-rich learning environments are shaped not only by individual student behaviour, but also by course design, lecturer expectations, assessment structures, digital workload, platform integration, and institutional support systems. Multi-level research could therefore clarify how institutional digital governance and classroom climates interact with individual technostress, cyberloafing, and procrastination. Such work would help develop a more complete and context-sensitive understanding of student satisfaction in contemporary higher education.

Declarations

INFORMED CONSENT

Written informed consent was obtained in person using a paper-based consent form. Before taking part, all prospective respondents received a clear explanation of the study aims, procedures, possible risks and benefits, guarantees of confidentiality, and their freedom to discontinue participation at any point without negative consequences. Only after reading this information and indicating that they fully understood it did they voluntarily sign the consent form, thereby confirming their willingness to participate. This procedure was completed for all 2,111 participants, who were higher education students enrolled in Diploma, Bachelor, Master, and Doctoral programmes at several universities in East and Central Java, Indonesia. Consent was collected between August 2024 and April 2025. Once the signed consent had been obtained, participants were given access to the electronic questionnaire and completed it online via Google Forms.

CONFLICT OF INTEREST

The authors declare that he/she has no conflict of interest.

CLINICAL TRIAL NUMBER

Not applicable.

CONSENT TO PUBLISH

Not applicable. The manuscript does not contain identifiable individual participant information.

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Author Contribution

Conceptualization, F.S., I.F.A., R.P.A., P.Y.W. and E.F.S.; methodology, I.F.A., F.N.D.N., M.F.M. and A.A.; software, I.F.A., F.S. and L.M.D.; validation, F.S., R.A.Z. and E.F.S.; formal analysis, F.S., M.F.M. and E.F.S.; investigation, I.F.A., F.S., P.Y.W., R.P.A., M.F.M., F.N.D.N., A.A., R.A.Z., E.R., L.M.D. and E.F.S.; resources, I.F.A., F.S., R.P.A., A.A.; data curation, I.F.A., F.N.D.N., A.A. and E.R.; writing—original draft preparation, I.F.A., F.S., P.Y.W., R.P.A., M.F.M., F.N.D.N., A.A., R.A.Z., E.R., L.M.D., and E.F.S.; writing—review and editing, I.F.A., F.S., P.Y.W., R.P.A., M.F.M., F.N.D.N., A.A., R.A.Z., E.R., L.M.D., and E.F.S.; visualization, I.F.A., F.N.D.N., A.A. and L.M.D.; supervision, F.S., P.Y.W. and M.F.M.; project administration, I.F.A., F.S. and E.R.; funding

acquisition, F.S., R.P.A. and E.F.S. All authors have read and agreed to the published version of the manuscript.

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Data Availability

The authors will provide the original data that supported the conclusions of this article without any undue reservation.

ETHIC APPROVAL

The study involving human participants was conducted in accordance with the 1964 Declaration of Helsinki and relevant ethical guidelines and regulations. Ethical approval was granted by the Institutional Ethics Committee at Sekolah Pascasarjana, Universitas Airlangga (Approval ID: 6656/B/UN3.SPS/I/PT.04.08/2024) on August 8th, 2024.

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Tables

Table 1. Respondent Demography.

Category	Doctoral Program		Master Program		Bachelor Program		Diploma Program	
	f	%	f	%	f	%	f	%
<i>Age (years)</i>								
<18	-	-	-	-	177	20.34	105	17.80
18 – 20	-	-	-	-	357	41.03	386	65.42
21 – 23	-	-	49	11.14	201	23.10	94	15.93
24 – 26	9	4.27	143	32.50	56	6.44	5	0.85
27 – 30	58	27.49	189	42.95	45	5.17	-	-
>30	144	68.25	59	13.41	34	3.91	-	-
<i>Gender</i>								
Male	133	63.03	206	46.82	377	43.33	345	58.47
Female	78	36.97	234	53.18	493	56.67	245	41.53
<i>GPA</i>								
3.75 – 4.00	52	24.64	147	33.41	148	17.01	203	34.41
3.50 – 3.74	47	22.27	176	40.00	344	39.54	137	23.22
3.25 – 3.49	106	50.24	117	26.59	112	12.87	203	34.41
3.00 – 3.24	6	2.84	-	-	104	11.95	30	5.08
2.75 – 3.00	-	-	-	-	116	13.33	17	2.88
< 2.75	-	-	-	-	46	5.29	-	-
<i>Faculty</i>								
Postgraduate School	83	39.34	185	42.05	-	-	-	-
Social Sciences & Political Sciences	32	15.17	27	6.14	115	13.22	45	7.63
Businness & Management	55	26.07	112	25.45	256	29.43	67	11.36
Psychology	7	3.32	25	5.68	170	19.54	-	-
Law	23	10.90	78	17.73	249	28.62	-	-
Humanities	11	5.21	13	2.95	80	9.20	-	-
Vocational	-	-	-	-	-	-	478	81.02
<i>Place of Origin</i>								

Category	Doctoral Program		Master Program		Bachelor Program		Diploma Program	
	f	%	f	%	f	%	f	%
In the university's city of location	144	68.25	304	69.09	337	38.74	433	73.39
Out of town	47	22.27	56	12.73	75	8.62	36	6.10
Boarding house or student dormitory	20	9.48	80	18.18	458	52.64	121	20.51
<i>Active Membership in Student Organizations *</i>								
Yes	5	2.37	78	17.73	756	86.90	544	92.20
No	206	97.63	362	82.27	114	13.10	46	7.80
<i>Student Status</i>								
Full-time student	17	8.06	314	71.36	774	88.97	548	92.88
Part-time student	194	91.94	126	28.64	96	11.03	42	7.12
<i>Scholarship</i>								
Funded / Awardee	11	5.21	156	35.45	203	23.33	198	33.56
Self Funded	200	94.79	284	64.55	667	76.67	392	66.44
N Total	211	100	440	100	870	100	590	100

** Student Activity Units; Student Executive Board; Student Study Program Associations; Student Professional Associations; External Student Organizations*

Table 2. Results of Convergent Validity and Reliability Testing.

Item/Variable		OL
Technostress (5-item) (Alvarez-Risco et al., 2021) (CA = 0.721; CR = 0.827; AVE = 0.544)		
<i>As a university student...</i>		
TS1	... I feel pressured by social media to keep a very tight schedule for classes, assignments, and campus activities.	0.734
TS2	... I feel compelled to change my study habits and daily routines to adapt to new developments on social media.	0.741
TS3	... I often sacrifice personal time (including study and rest) to stay current with social media updates.	0.732
TS4	... I feel that social media intrudes on my personal life as a student.	0.745
Cyberloafing (30-item) (Akbulut et al., 2016) (CA = 0.971; CR = 0.973; AVE = 0.543)		
<i>Sharing Dimension (9-item) (CA = 0.915; CR = 0.930; AVE = 0.597)</i>		
CSG1	I regularly check posts from friends and classmates.	0.769
CSG2	I browse friends' and classmates' profiles on social networks.	0.779
CSG3	I share content (photos, videos, etc.) on my social media accounts.	0.771
CSG4	I like posts that I find interesting.	0.782
CSG5	I leave comments on photos that others share.	0.767
CSG6	I post status updates on my social networks.	0.777
CSG7	I tag friends or classmates in photos.	0.761
CSG8	I chat with friends and classmates through social apps.	0.767
CSG9	I watch videos shared by others on social media.	0.778
<i>Shopping Dimension (9-item) (CA = 0.900; CR = 0.921; AVE = 0.625)</i>		
CSH1	I shop online.	0.797
CSH2	I browse daily-deal websites.	0.801
CSH3	I visit e-commerce sites.	0.792
CSH4	I visit online auction sites.	0.791
CSH5	I use online banking services.	0.786
CSH6	I browse online marketplaces for second-hand items.	0.787
CSH7	I check online job advertisements.	0.778
<i>Real-Time Updating Dimension (5-item) (CA = 0.864; CR = 0.902; AVE = 0.647)</i>		

Item/Variable		OL
CRU1	I repost or retweet; tweets I like.	0.794
CRU2	I like or bookmark tweets I enjoy.	0.814
CRU3	I post tweets.	0.810
CRU4	I read tweets.	0.804
CRU5	I comment on trending topics in real time.	0.802
<i>Accessing Online Content Dimension (5-item) (CA = 0.859; CR = 0.899; AVE = 0.639)</i>		
CAO1	I download music.	0.794
CAO2	I watch videos online.	0.804
CAO3	I stream music online.	0.806
CAO4	I download videos.	0.795
CAO5	I download applications I need for classes or campus life.	0.799
<i>Gaming / Gambling Dimension (5-item) (CA = 0.845; CR = 0.896; AVE = 0.682)</i>		
CGA1	I visit online betting sites.	0.825
CGA2	I place bets online.	0.833
CGA3	I check sports websites online.	0.825
CGA4	I play online games.	0.822
Academic Procrastination (5-item) (Yockey, 2016) (CA = 0.798; CR = 0.861; AVE = 0.553)		
APC1	I tend to delay my course projects until the last minute.	0.722
APC2	Even when I know I should be working on my coursework, I don't start.	0.744
APC3	When I'm supposed to work on coursework, I get sidetracked by more enjoyable activities.	0.738
APC4	After I receive an assignment, I usually set it aside and don't return to it until the deadline is near.	0.751
APC5	I often put off tasks that have important academic deadlines.	0.762
Student Satisfaction (5-item) (Pedro et al., 2023) (CA = 0.786; CR = 0.853; AVE = 0.537)		
SS1	Overall, I am satisfied with my academic experience and campus social life.	0.755
SS2	My experience at this university matches my expectations.	0.730
SS3	I feel physically healthy while studying at this university.	0.754
SS4	I feel that my university provides a safe environment.	0.727

Item/Variable		OL
SS5	The overall cost of attending this university is generally acceptable to me.	0.696
Social Pressure (5-item) (Casanova et al., 2019) (CA = 0.792; CR = 0.856; AVE = 0.599)		
SP1	I aim to live up to my family's expectations for my university education.	0.802
SP2	I try not to disappoint my family or friends with my academic performance.	0.695
SP3	I want to honor the wishes of those close to me who encouraged me to pursue higher education.	0.846
SP4	I strive to attain an educational level equal to or higher than that of my parents or older siblings.	0.744

Note: TS = Technostress; CSG = Cyberloafing (Sharing); CSH = Cyberloafing (Shopping); CRU = Cyberloafing (Real-Time Updating); CAO = Cyberloafing (Accessing Online Content); CGA = Cyberloafing (Gaming/Gambling); APR = Academic Performance; SS = Student Satisfaction; SP = Social Pressure; OL = Outer Loading; CA = Cronbach's Alpha; CR = Composite Reliability; AVE = Average Variance Extracted.

Table 3. Fornell–Larcker criterion.

Variable	APC	CL	SP	SS	TS
Academic Procrastination	0.743				
Cyberloafing	0.534	0.737			
Social Pressure	-0.022	0.014	0.774		
Student Satisfaction	-0.247	-0.079	-0.052	0.733	
Technostress	0.321	0.353	-0.035	-0.061	0.738

Note: TS = Technostress; CL = Cyberloafing; APC = Academic Procrastination; SS = Student Satisfaction; SP = Social Pressure.

Table 4. Heterotrait–Monotrait Ratio (HTMT).

Variable	APC	CL	SP	SS	TS	SPxAPC
Academic Procrastination						
Cyberloafing	0.606					
Social Pressure	0.044	0.027				
Student Satisfaction	0.310	0.088	0.057			
Technostress	0.423	0.421	0.054	0.082		
Social Pressure x Academic Procrastination	0.150	0.164	0.130	0.127	0.087	

Note: TS = Technostress; CL = Cyberloafing; APC = Academic Procrastination; SS = Student Satisfaction; SP = Social Pressure.

Table 5. Structural Path Estimates, Effect Sizes, and Mediation Classification.

H	Path	β	SD	t-values	p-values	f ²	Effect size / Mediation Type	Results
H1	TS → APC	0.152	0.033	4.659	< 0.001	0.029	Small	Supported
H2	CL → APC	0.480	0.038	12.671	< 0.001	0.291	Medium	Supported
H3	APC → SS	-0.284	0.026	10.945	< 0.001	0.061	Small	Supported
H4	TS → SS	-0.040	0.026	1.528	0.126	0.000	Negligible	Not supported
H5	CL → SS	-0.048	0.026	1.883	0.060	0.006	Negligible	Not supported
H6	TS → APC → SS	-0.043	0.010	4.200	< 0.001	N/A	Full mediation	Supported
H7	CL → APC → SS	-0.137	0.019	7.269	< 0.001	N/A	Full mediation	Supported
H8	SP × APC → SS	-0.097	0.030	3.230	0.001	0.010	Very small	Supported

Note: H = Hypothesis; TS = Technostress; CL = Cyberloafing; APC = Academic Procrastination; SS = Student Satisfaction; SP = Social Pressure; β = path coefficient; SD = bootstrapped standard deviation. f² values were interpreted using conventional benchmarks: 0.02 = small, 0.15 = medium, and 0.35 = large. Values below 0.02 were interpreted as very small or negligible. f² is reported for direct and moderation paths only and is not applicable to indirect effects. Full mediation is indicated when the indirect effect is significant and the corresponding direct effect is not significant.

Table 6. Blindfolding Test.

Variable	SSO	SSE	Q ² (=1-SSE/SSO)
APC	10555.000	8394.926	0.205
CL	63330.000	63330.000	0.000
SP	8444.000	8444.000	0.000
SS	10555.000	10128.256	0.040
TS	8444.000	8444.000	0.000

Note: TS = Technostress; CL = Cyberloafing; APC = Academic Procrastination; SS = Student Satisfaction; SP = Social Pressure; SSO = Sum of Squared Observations; SSE = Sum of Squared Prediction Errors; Q² = Stone–Geisser’s Q² Predictive Relevance.

Table 7. IPMA Test.

Variable	Importance (Total Effect on SS)	Performance (0-100 Score)	Intervention Priority
APC	-0.284	90.318	Very Low Priority
CL	-0.048	80.494	Medium Priority
SP	-0.070	89.991	Low Priority
TS	-0.040	74.810	Highest Priority

Note: TS = Technostress; CL = Cyberloafing; APC = Academic Procrastination; SS = Student Satisfaction; SP = Social Pressure.

Table 8. PLS MV-LV Predict Test.

Variable	Q ² predict	PLS-SEM_RMSE	PLS-SEM_MAE
APC	0.301	0.842	0.575
APC1	0.143	0.664	0.529
APC2	0.159	0.644	0.516
APC3	0.154	0.642	0.510
APC4	0.177	0.640	0.505
APC5	0.190	0.645	0.509
SS	0.010	0.996	0.835
SS1	0.009	1.044	0.921
SS2	0.006	1.029	0.905
SS3	0.010	1.015	0.890
SS4	0.003	1.039	0.915
SS5	-0.001	1.036	0.910

Note: APC = Academic Procrastination; SS = Student Satisfaction; Root Mean Squared Error; MAE = Mean Absolute Error.

Figures

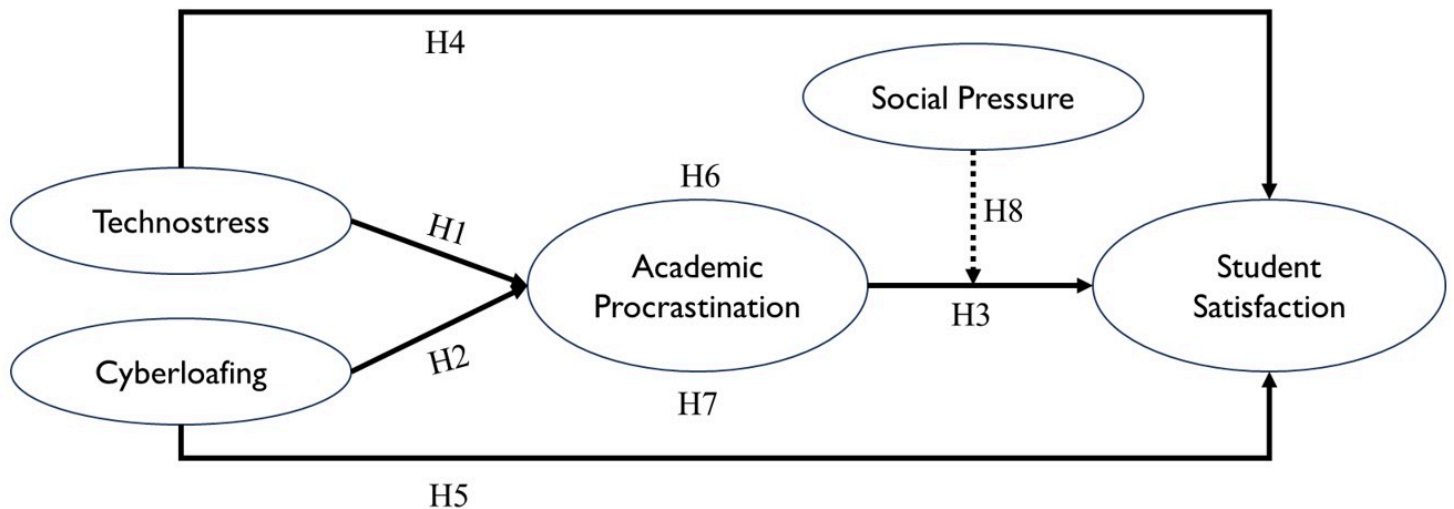


Figure 1

Research Model Framework.

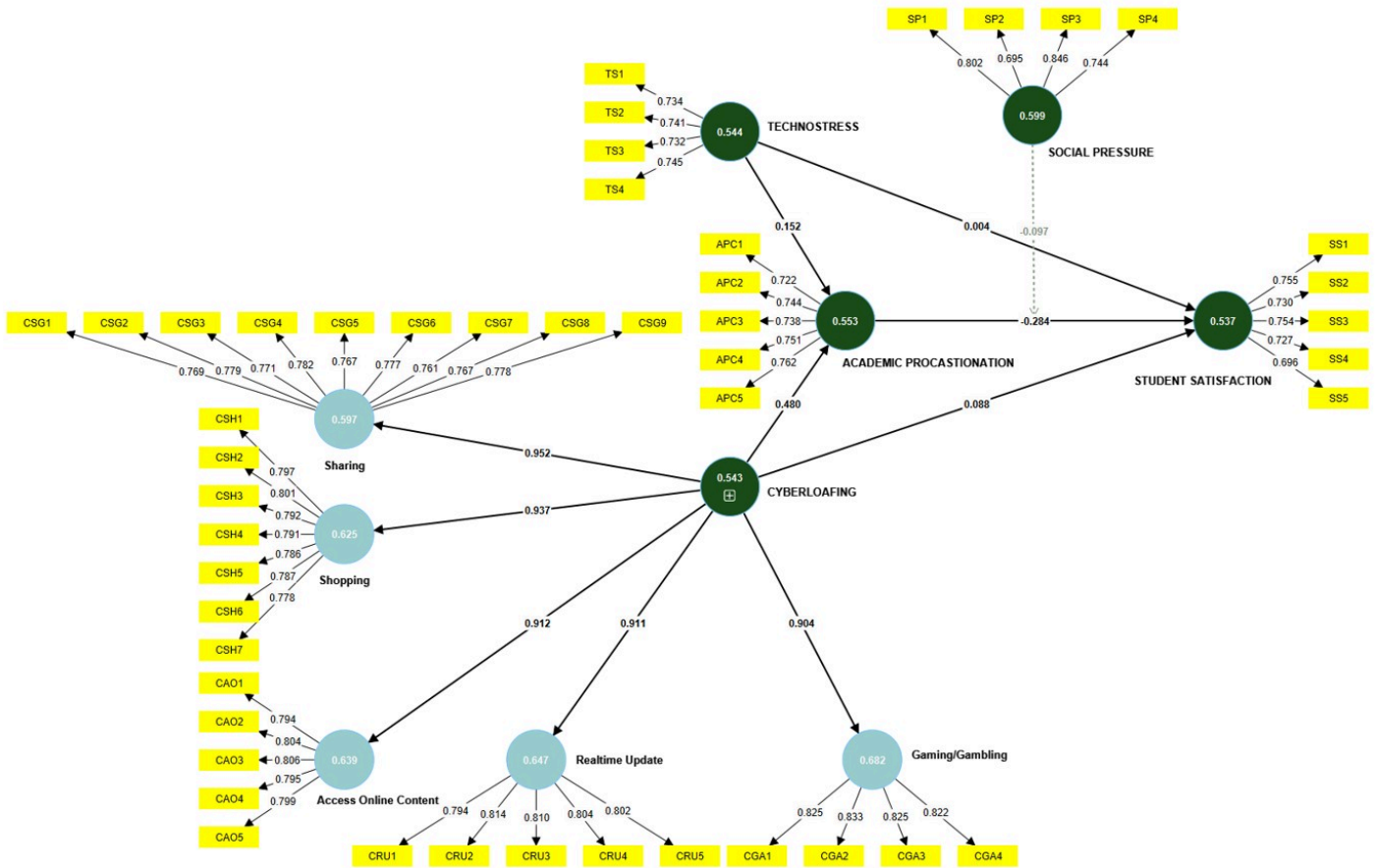


Figure 2

Outer Loading Test Result.

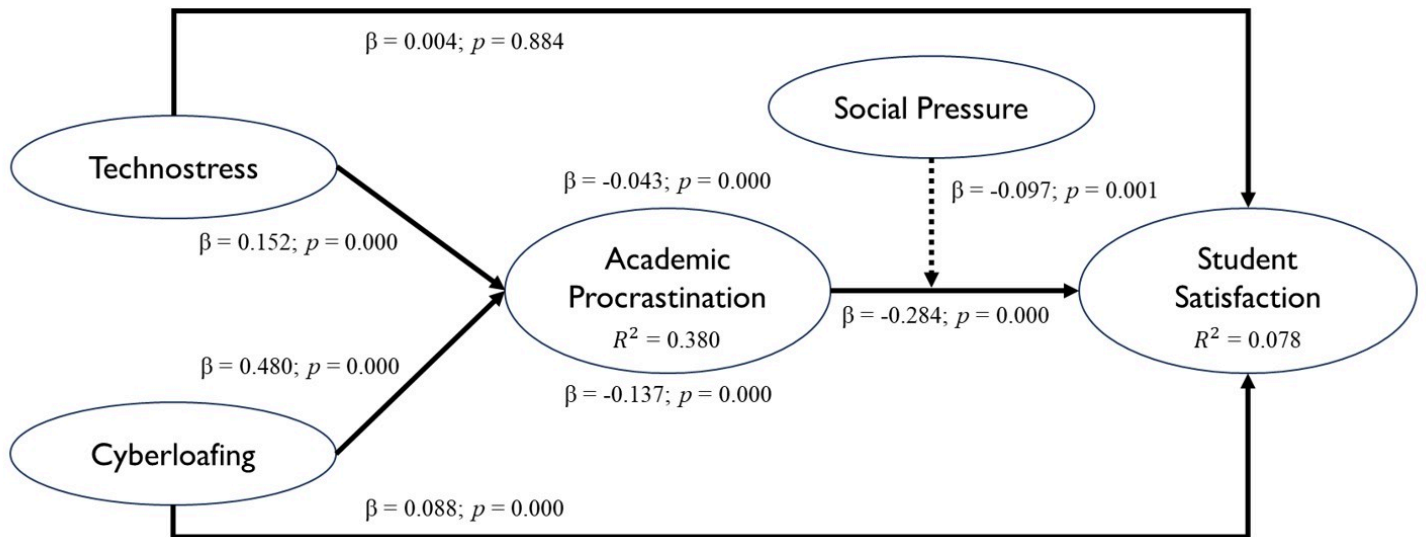


Figure 3

Structural Equation Test Result.

Note: β = path coefficient; p = probability values (significancy); R^2 = coefficient of determination

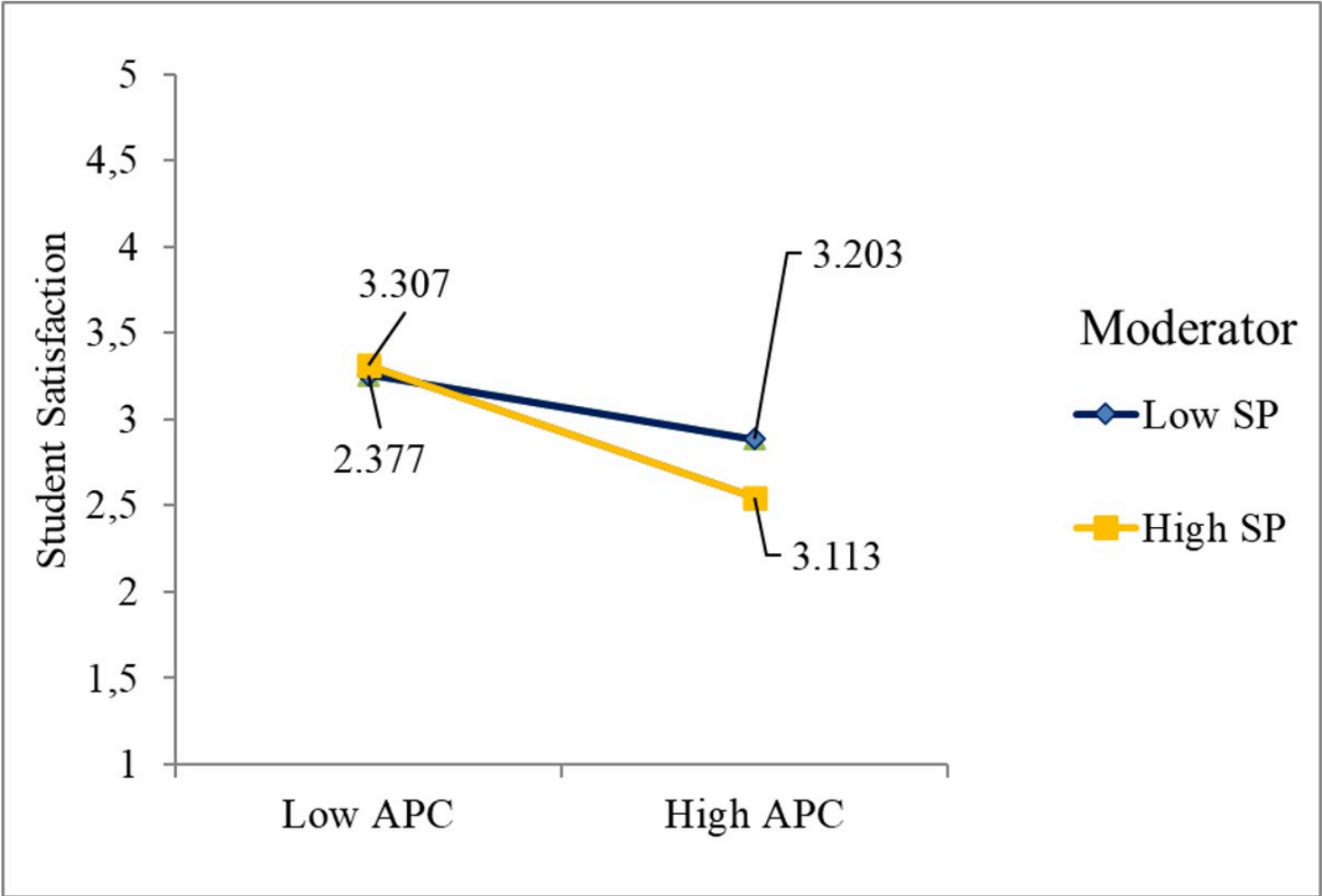


Figure 4
SP moderating effect illustration on relationship APC to SS.