AI-DRIVEN DIGITALISATION AND LIFE SATISFACTION AMONG PROFESSORS: A PARALLEL MEDIATION ANALYSIS BY FAMILY FUNCTIONING AND DIGITAL DEVICE USE

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Abstract: *AI-driven digitalisation is accelerating "always-on" work patterns in academia, especially for tech-savvy STEM professors whose teaching, research, and administrative tasks increasingly rely on digital tools. This shift can intensify work-to-home spillover and challenge digital life balance, with potential consequences for wellbeing. This study examines how family functioning profiles and AI-related digital device use jointly shape the link between negative work-to-home interaction and life satisfaction among STEM faculty. Cross-sectional survey data were collected from STEM university professors (N = 735; ages 18–66). Measures included negative work-to-home interaction (SWING subscale), life satisfaction (SWLS), family functioning profiles (balanced flexibility, rigidity, chaotic functioning), and frequency/duration of AI-related digital device use from the Artificial Intelligence–Digital Life Balance Scale (AI-DLBS). We tested a parallel mediation model, including relevant covariates (e.g., age, gender), and estimated indirect effects with confidence intervals. Negative work-to-home interaction was significantly associated with lower life satisfaction (direct effect b = −0.360, p < .001). Significant indirect effects were observed through balanced family flexibility (b = −0.075, p < .001), rigid family functioning (b = −0.015, p = .046), and AI-related digital device use*

frequency/duration ($b = -0.084$, $p < .001$), whereas the pathway through chaotic functioning was not significant. The total effect remained substantial ($b = -0.546$, $p < .001$), indicating partial mediation. In AI-assisted academic work, digital boundary management and family flexibility represent key leverage points for sustaining wellbeing among STEM professors. Institutional policies that reduce after-hours digital demands and support boundary-setting may protect life satisfaction in contexts of high work-to-home spillover.

Keywords: *artificial intelligence; digitalisation; professors; higher education; work–home spillover; digital life balance; family functioning; life satisfaction; boundary management.*

Introduction

AI-driven digitalisation is reshaping contemporary job management by accelerating "always-on" work patterns, expanding the portability of tasks, and lowering the friction of continuing work beyond formal hours. In higher education, these shifts are particularly salient because teaching, research, and administrative work are increasingly mediated through platforms, data infrastructures, and AI-enabled tools that support drafting, revision, feedback, and workflow automation (Sethi & Singh, 2024; Nguyen et al., 2024). Systematic evidence on AI-assisted learning—especially around the rapid diffusion of ChatGPT in universities—suggests that AI can enhance productivity and learning support, while simultaneously introducing risks related to dependency, academic integrity, uneven preparedness, and institutional governance gaps (Vargas-Murillo et al., 2023). Human–AI collaboration research further indicates that AI is not simply a tool layered on top of existing routines; it reorganizes how academic tasks are sequenced (e.g., ideation → outlining → drafting → revision), shifting cognitive load and reconfiguring time demands in ways that can spill into private life (Nguyen et al., 2024).

The integration of AI into academic work is also accompanied by expanding legal, ethical, and infrastructural concerns. Regulatory discussions increasingly address accountability, authorship, and compliance pathways for AI-assisted academic writing, signalling that AI use has become a governance-relevant feature of knowledge work rather than a purely individual practice (Gao et al., 2025). Related developments include AI-assisted peer review, where classification and application models reflect a broader automation of evaluation

processes (Tong et al., 2021), and technical proposals for secure AI-assisted writing platforms that foreground privacy, robustness, and risk mitigation as prerequisites for responsible institutional adoption (Qureshi et al., 2024). In the social sciences, the debate about whether researchers should act as gatekeepers or revolutionaries underscores the field's active negotiation of ethical boundaries and methodological accountability under AI-mediated research practices (Runcan et al., 2025). Conceptual critiques from affective science also caution that AI can generate persuasive "illusions of measurement," reinforcing the need for theoretically grounded constructs and rigorous operationalization when investigating psychological outcomes in AI-saturated environments (Rad et al., 2025).

These transformations converge on a long-standing issue in organizational research: boundary management between work and nonwork roles. Classic work on personal digital assistants already documented how mobile technologies extend availability and create new negotiation points between professional and personal domains (Golden & Geisler, 2007). Subsequent frameworks show that boundary management in the digital age depends on the permeability of boundaries, role transition practices, and the degree of control individuals can exert over availability and response norms (Kossek, 2016; Basile & Beauregard, 2020). Sociological perspectives add that boundary control is unequally distributed: it is shaped by "digital cultural capital," organizational norms, and power, such that the same connectivity can translate into autonomy for some and intensified surveillance or expectations for others (Ollier-Malaterre et al., 2019). Recent empirical findings link constant connectivity to boundary management behaviors through human agency, suggesting that perceived control and intentionality can moderate how pervasive digital access affects every day boundary practices (Farivar et al., 2024). Complementarily, boundary work research in lean and digitalisation programs illustrates how organizations institutionalize boundary practices—either encouraging integration for efficiency or enforcing separation for clarity—thereby making boundary management a structural feature of digital transformation rather than an individual preference alone (Pirrone et al., 2024). Parallel insights from innovation settings show how "digital boundary control" becomes a managerial mechanism for structuring participation and regulating access in platform contexts, further underscoring boundary control as a strategic problem in digitally mediated work (Gandia & Parmentier, 2020).

In academia, boundary dynamics are intensified by the characteristic structure of university work: high autonomy coupled

with strong performance pressures, overlapping role demands, and the normalization of after-hours productivity. Research on university labor highlights how freedom and flexibility frequently coexist with intensification and strain, making work–family balance difficult to sustain (Nikunen, 2012; Wilton & Ross, 2017). Importantly, formal flexibility does not automatically translate into practical boundary control. In scientific and engineering contexts, flexibility stigma can penalize the use of family-supportive practices by signalling reduced commitment, thereby reducing faculty members' willingness or ability to protect boundaries (Cech & Blair-Loy, 2014). Gender and climate dynamics further shape these experiences: perceived support for family commitments relates to satisfaction in academia and differs across disciplinary contexts, including STEMM versus non-STEMM fields (Moors et al., 2014), while chilly interpersonal climates can operate as chronic barriers to wellbeing for early-career women in STEM (Miner et al., 2019). A broader narrative synthesis of faculty mental health identifies workload, role conflict, institutional pressures, and limited support as recurring drivers of diminished wellbeing, reinforcing the need for models that connect work organization with psychological outcomes (Hammoudi Halat et al., 2023).

Taken together, existing evidence suggests that AI-enabled digitalisation can intensify work-to-home spillover by increasing work's portability and reducing the effort required to continue tasks beyond formal hours. Yet, the impact of spillover on wellbeing likely depends on resources and practices that shape boundary permeability and recovery. In this regard, family functioning can be conceptualized as a proximal social-system resource that supports regulation, role negotiation, and recovery routines at home, whereas AI-related digital device use (frequency/duration) can be treated as an operational marker of boundary permeability—capturing how strongly academic work penetrates nonwork time through AI-assisted digital engagement (Golden & Geisler, 2007; Kossek, 2016; Farivar et al., 2024). This integrative framing aligns with contemporary boundary scholarship emphasizing the interplay between individual agency, organizational expectations, and technology-mediated norms (Ollier-Malaterre et al., 2019; Basile & Beauregard, 2020; Pirrone et al., 2024). It also responds to the wider call for ethically and conceptually robust research on AI in academic contexts, where measurement, accountability, and governance are central rather than peripheral concerns (Runcan et al., 2025; Rad et al., 2025; Gao et al., 2025).

Positioning within this Special Issue's theme—disruptions in contemporary job management—this paper focuses on tech-savvy STEM professors as a strategically relevant group: they are early

adopters and intensive users of digital tools, they often operate under performance regimes shaped by metrics and deadlines, and they are likely to experience pronounced work-to-home spillover as work becomes more digitally "portable." While AI adoption research in other professional domains (e.g., managerial accounting) increasingly models pathways from AI knowledge to AI usage intentions and acknowledges the role of individual differences (Cuc et al., 2025), a comparable explanatory focus is needed in higher education to clarify how AI-enabled digitalisation intersects with boundary management and wellbeing among STEM faculty.

RQ: Among tech-savvy STEM professors, to what extent does negative work-to-home spillover predict life satisfaction, and is this relationship explained (in parallel) by family functioning profiles and AI-related digital device use as indicators of digital boundary permeability in AI-assisted academic work?

Theoretical Framework

AI-enabled digitalisation and academic work: collaboration, governance, and infrastructure

AI tools are increasingly embedded in everyday academic writing and learning practices. Empirical work on human–AI collaboration patterns in AI-assisted academic writing shows heterogeneous usage styles—ranging from ideation and outlining to revision and polishing—suggesting that AI changes not only efficiency but also the sequencing and cognitive organization of scholarly production (Nguyen et al., 2024). Systematic literature synthesis on ChatGPT in higher education similarly reports a dual narrative: AI can support learning, feedback, and personalized scaffolding, while also raising concerns about integrity, dependency, and uneven preparedness across users and institutions (Vargas-Murillo et al., 2023). In blended learning contexts, AI is often framed as a catalyst for adaptation and institutional transformation, pushing universities to evolve pedagogical models and staff practices in tandem with technology uptake (Sethi & Singh, 2024).

However, this integration also intensifies the need for governance. Legal and regulatory analysis underscores challenges in defining accountability, acceptable use, and compliance frameworks for AI-assisted academic writing, highlighting pathways for institutional policy and broader regulatory alignment (Gao et al., 2025). Beyond writing, AI is entering peer-review ecosystems, where classification and application models signal a broader transformation of academic quality assurance (Tong et al., 2021). At the infrastructure level, proposals for robust and secure AI-assisted academic writing platforms

emphasize security, privacy, and resilience—factors that are not peripheral but central to trustworthy AI adoption in academic institutions (Qureshi et al., 2024). Simultaneously, researchers in the social sciences are debating whether they should act primarily as gatekeepers of ethical compliance or as innovators shaping responsible AI transformation—an argument that foregrounds the importance of transparency, fairness, and reflexivity in AI-mediated knowledge work (Runcan et al., 2025). Conceptual critiques from affective science further add that AI-supported measurement and interpretation can be deceptively persuasive, requiring methodological humility and careful construct validity reasoning when AI outputs are used to infer psychological states or performance (Rad et al., 2025).

Boundary management in the digital age: from connectivity to agency and boundary work

Boundary management scholarship provides a well-established framework for understanding how digital work reconfigures work–home relations. Early research on personal digital assistants already documented how portable technologies enable work extension and introduce new boundary negotiations into daily life (Golden & Geisler, 2007). Later conceptualizations emphasize that boundary management in the digital age is shaped by both individual strategies and organizational expectations, with permeability rising as communication channels multiply and response norms accelerate (Kossek, 2016). Practical and applied perspectives highlight that "getting the work-home balance right" requires deliberate boundary management choices (segmentation vs. integration), role transitions, and organizational support structures—particularly under agile and digitally enabled work arrangements (Basile & Beauregard, 2020).

Sociological theory expands this picture by introducing digital cultural capital: the idea that individuals' ability to manage boundaries depends not just on preferences, but on learned competencies, norms, resources, and status positions that shape the "right" to disconnect and the ability to control one's availability (Ollier-Malaterre et al., 2019). Recent empirical research connects constant connectivity to boundary management behaviors through human agency, suggesting that individuals' sense of control and intentionality can either mitigate or amplify the effects of pervasive digital access (Farivar et al., 2024). Complementing this, research on boundary work management in lean and digitalization programs shows that organizations often institutionalize boundary practices—sometimes encouraging integration for efficiency, sometimes enforcing separation for clarity—revealing boundary management as a meso-level process shaped by

program logics and managerial decisions (Pirrone et al., 2024). Even in innovation settings, boundary control becomes a strategic management function; digital boundary control in platform-mediated open innovation illustrates how organizations structure access, participation, and control to manage collaboration and performance (Gandia & Parmentier, 2020). Taken together, these studies imply that AI-enabled academic work should be studied as a boundary reconfiguration problem: the same technologies that enable productivity can also institutionalize "default connectivity," thereby altering boundary norms and wellbeing trajectories.

Faculty wellbeing and work–family dynamics in STEM academia: flexibility, stigma, climate, and support

Higher education has distinctive working conditions that complicate standard work–life models. Analyses of university work describe a tension between perceived freedom and intensifying demands, where flexibility is frequently accompanied by higher expectations and blurred boundaries (Nikunen, 2012). Empirical research further suggests that academic flexibility can require sacrifice and can be experienced as insecurity, especially when career progression depends on continuous visibility and productivity (Wilton & Ross, 2017). Within academic science and engineering, flexibility stigma is a critical mechanism: the perception that using family-supportive flexibility policies signals lower commitment and can trigger career penalties, effectively reducing the real options available to faculty and researchers (Cech & Blair-Loy, 2014).

The wellbeing landscape is also shaped by gendered patterns and institutional climates. Evidence indicates that perceived support for family commitments is associated with satisfaction in academia and differs across gender and disciplinary contexts, including STEMM versus non-STEMM fields (Moors et al., 2014). For early-career women in STEM, "chilly" interpersonal climates can operate as a barrier to wellbeing, signaling that social context and everyday interaction patterns matter alongside structural policies (Miner et al., 2019). Broader narrative synthesis on faculty mental health points to workload intensification, role conflict, limited resources, and organizational pressures as recurrent contributors to diminished wellbeing and psychological strain (Hammoudi Halat et al., 2023). These findings collectively suggest that AI-enabled digitalisation may not affect all faculty equally: its effects are likely conditioned by climate, support, stigma dynamics, and the availability of agency and control over boundaries.

Linking AI-driven digitalisation, boundary management, and wellbeing: why a mediation logic is theoretically warranted

Across these literatures, a coherent theoretical premise emerges: AI-driven digitalisation changes the temporal and spatial organization of work, which increases work-to-home spillover; spillover, in turn, undermines wellbeing unless buffered by effective boundary management resources. In the academic context, family functioning and home-system organization can be conceptualized as key resources that shape how spillover is processed—either as manageable strain or as chronic interference. At the same time, AI-related digital device use can be read as an operational marker of boundary permeability: higher frequency/duration of digitally mediated work may reflect intensified integration and reduced recovery opportunities. This logic is consistent with boundary theory's focus on permeability and control (Kossek, 2016; Basile & Beauregard, 2020), with the agency-focused account of constant connectivity (Farivar et al., 2024), and with the institutionalization of boundary work under digitalization programs (Pirrone et al., 2024). It also aligns with the broader argument that digital cultural capital and status-based "rights to disconnect" shape boundary outcomes (Ollier-Malaterre et al., 2019), and with evidence that academic contexts can penalize flexibility use (Cech & Blair-Loy, 2014).

Finally, the ethics and governance strand underscores why this topic is timely and relevant to job management disruptions: AI tools are not only changing work content; they are altering responsibility structures, compliance expectations, and the legitimacy conditions for academic outputs (Gao et al., 2025; Runcan et al., 2025; Tong et al., 2021). In parallel, conceptual critiques caution against treating AI-enabled outputs as straightforward indicators of psychological or performance constructs, strengthening the case for using validated psychological measures and transparent modeling when studying wellbeing in AI-mediated work settings (Rad et al., 2025). By integrating these perspectives, the present study contributes to the Special Issue by explaining a concrete mechanism through which AI-driven digitalisation may influence job management and wellbeing among tech-savvy STEM professors—through work-to-home spillover, digital boundary permeability, and family-system resources.

Materials and Methods

Study design and procedure

The present study used a cross-sectional, correlational survey design to examine whether negative work-to-home spillover predicts life satisfaction among tech-savvy STEM professors, and whether this

association is explained in parallel by family functioning profiles and AI-related digital device use (frequency/duration) as indicators of digital boundary permeability in AI-assisted academic work. Data were collected online using a Google Forms questionnaire that included an informed-consent page, eligibility screening items, and the study measures presented in a fixed order. Participation was voluntary and anonymous; no directly identifying information was requested, and responses were downloaded and stored on password-protected devices accessible only to the research team.

Participants were recruited through professional academic networks (departmental mailing lists and collegial dissemination within universities), using a convenience sampling approach. The recruitment message specified that the study targeted STEM professors who routinely use digital tools and AI-enabled resources in their academic tasks (teaching, research, or administration). Data collection took place in Western Romania.

Participants

A total of 735 STEM professors from Western Romania completed the questionnaire (age range 18–66, M = 40.26, SD = 10.84). The sample was predominantly female (90.6%). This gender distribution is plausible in the present context for two complementary reasons. First, convenience sampling via professional networks can amplify participation from groups that are more reachable through the researchers' dissemination channels and more responsive to voluntary survey invitations (e.g., collegial forwarding within departments). Second, the study topics—work–home spillover, family functioning, and digital life balance—may be perceived as especially salient and personally relevant, which can increase participation rates among women in faculty roles who often report higher exposure to work–family role demands in academic settings. To reduce the risk that this imbalance would distort substantive conclusions, gender was treated as a covariate in the subsequent models. Most respondents reported employment in the public sector (86.9%), consistent with the institutional structure of Romanian higher education. Additional characteristics are presented in Table 1.

Inclusion criteria were: (a) current academic employment as teaching staff in a STEM-relevant field, (b) residence/working context in Western Romania, (c) completion of informed consent, and (d) sufficient survey completion for inclusion in the analytic dataset. No incentives were offered.

Characteristic	Category	n	%
Gender	Female	666	90.6
	Male	69	9.4
Highest completed education	Secondary (high school)	31	4.2
	Post-secondary/vocational	7	1.0
	Bachelor's	381	51.8
	Master's	305	41.5
	Doctoral	11	1.5
Marital/relationship status	Married	466	63.4
	In a stable relationship	65	8.8
	Single (unmarried)	134	18.2
	Divorced	60	8.2
	Widowed	10	1.4
Occupational status	Public sector employee	639	86.9
	Private sector employee	65	8.8
	Entrepreneur/business owner	16	2.2
	Freelancer/independent	15	2.0
Total work tenure	< 1 year	52	7.1
	1–5 years	107	14.6
	6–10 years	85	11.6
	11–20 years	176	23.9
	> 20 years	315	42.9

Note. Percentages are based on valid responses (no missing data on these variables).

Table 1. Participant characteristics (N = 735)

Participants' age ranged from 18 to 66 years (M = 40.26, SD = 10.84), indicating a predominantly mid-career sample with substantial variability across early-, mid-, and later-career stages.

Instruments

Negative spillover from work to home was assessed with the Survey Work–Home Interaction–Nijmegen (SWING), using the Work Negatively Influencing Home subscale (Wagena & Geurts, 2000). The items capture the extent to which work demands and strain interfere with home life (e.g., becoming tense or irritable at home because of work). Responses were provided on a Likert-type frequency scale, with higher scores indicating stronger work-to-home interference. In the

present sample, the subscale showed excellent internal consistency (Cronbach's α = .93).

Global life satisfaction was measured using the Satisfaction With Life Scale (SWLS) (Diener et al., 1985). Participants rated their agreement with statements reflecting an overall cognitive evaluation of life. Items were summed, with higher scores indicating higher life satisfaction. Reliability in the current study was very good (Cronbach's α = .89).

Family flexibility (Family Flexibility Evaluation Scale; FACES IV—Flexibility dimensions).

Family flexibility was measured with the Family Flexibility Evaluation Scale, grounded in the FACES IV framework and the Circumplex Model (Gorall et al., 2004; Olson, 2011). Responses were provided on a 5-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). The instrument yields three flexibility-related profiles, Balanced Flexibility, Rigid Family, and Chaotic Family, computed by summing responses within each dimension; higher scores reflect stronger endorsement of the respective family flexibility pattern. In this sample (N = 735), internal consistency was acceptable for Balanced Flexibility (Cronbach's α = .73; standardized α = .75) and Rigid Family (Cronbach's α = .70; standardized α = .69), while lower for Chaotic Family (Cronbach's α = .56; standardized α = .58).

To capture regulation of daily digital device use in the context of AI-assisted academic activity, we used the Frequency and Duration of Digital Device Use factor from the Artificial Intelligence–Digital Life Balance Scale (AI-DLBS) (Erdemir & Atik, 2025). This indicator reflects planned, bounded, and purpose-driven device use (e.g., planning daily usage, using devices only when necessary, avoiding excessive prolongation). Responses were provided on a 1–7 Likert scale, and item scores were summed such that higher values indicate more regulated device use (i.e., stronger digital boundaries). For the present sample (N = 735), internal consistency was good (Cronbach's α = .849; standardized α = .858).

Results

This section first presents the descriptive profile of the study variables, offering an overall picture of central tendency and variability in the sample (N = 735). All measures had complete data (0 missing cases), allowing the analyses to be conducted on the full dataset.

Negative work-to-home spillover (Work Negatively Influencing Home) indicated a low-to-moderate average level of interference, suggesting that—on average—participants reported relatively limited transfer of work-related strain into the home domain (M = 1.946, SD =

0.605; range = 1.00–4.00). In contrast, global life satisfaction was generally high, reflecting predominantly positive evaluations of one's life circumstances (M = 5.758, SD = 0.950; range = 1.80–7.00).

Regarding family flexibility profiles, the sample tended to endorse Balanced Flexibility most strongly, pointing to an overall perception of adaptive family functioning and constructive flexibility in managing family roles and demands (M = 4.066, SD = 0.607; range = 1.00–5.00). The Rigid Family profile clustered closer to the midrange (M = 3.046, SD = 0.665; range = 1.00–5.00), while the Chaotic Family profile was comparatively lower, indicating weaker endorsement of disorganized or inconsistent flexibility patterns (M = 2.524, SD = 0.667; range = 1.00–5.00).

Finally, the Frequency and Duration of Digital Device Use (FDDDU) indicator reflected moderately high levels of planned and bounded device use, consistent with more regulated, purpose-driven engagement with digital technologies (M = 5.063, SD = 1.175; range = 1.667–7.00).

Table 2 summarizes the bivariate associations (Pearson's r) among negative work-to-home spillover, life satisfaction, family flexibility profiles, and regulated digital device use (FDDDU). Overall, the pattern shows a coherent network in which higher work-to-home strain is linked to lower well-being and more maladaptive family flexibility patterns, while more regulated digital device use aligns with higher well-being and more balanced family functioning.

Pearson's Correlations

Variable		Work negatively influencing home	Satisfaction with Life	Balanced Flexibility Family	Rigid Family	Chaotic Family	FDDDU
1. Work negatively influencing home	Pearson's r	—					
2. Satisfaction With Life		-0.348 ***	—				
3. Balanced Flexibility Family		-0.125 ***	0.469 ***	—			
4. Rigid Family		0.107 **	0.031	0.322 ***	—		
5. Chaotic Family		0.180 ***	-0.151 ***	-0.081 *	0.201 ***	—	
6. FDDDU		-0.209 ***	0.428 ***	0.337 ***	0.122 ***	-0.046	—

Pearson's Correlations

Variable	Work negatively influencing home	Satisfaction with Life	Balanced Flexibility Family	Rigid Family	Chaotic Family	FDDDU

* p < .05, ** p < .01, *** p < .001

Tabel 2. Correlation matrix

Negative work-to-home spillover was moderately and negatively related to life satisfaction ($r = -.348$, $p < .001$), indicating that participants who reported more work-related interference at home tended to evaluate their lives less positively. Spillover also showed a small negative association with balanced family flexibility ($r = -.125$, $p < .001$), suggesting that more work-to-home strain co-occurred with slightly lower perceptions of adaptive, well-regulated family flexibility. In contrast, spillover was positively associated with both rigid ($r = .107$, $p < .01$) and chaotic family profiles ($r = .180$, $p < .001$). Although these effects are small, they consistently indicate that higher work-to-home interference is linked to stronger endorsement of less optimal family flexibility patterns, particularly the chaotic profile.

Life satisfaction showed its strongest association with balanced flexibility, yielding a moderate positive correlation ($r = .469$, $p < .001$). This indicates that participants perceiving their families as more adaptively flexible also tended to report higher overall satisfaction with life. Conversely, life satisfaction was negatively related to chaotic family functioning ($r = -.151$, $p < .001$), consistent with the idea that disorganization or inconsistent flexibility in the family context corresponds to lower subjective well-being. The correlation between life satisfaction and rigid family functioning was very small and non-significant ($r = .031$, $p > .05$), suggesting that rigidity—as measured here—did not meaningfully covary with global life satisfaction at the bivariate level.

Relations among the three family flexibility profiles were also informative. Balanced flexibility correlated moderately and positively with rigid family functioning ($r = .322$, $p < .001$), implying that some elements of structure/consistency may co-occur with adaptive flexibility in this sample (i.e., these are not mutually exclusive tendencies). Balanced flexibility had a very small negative association with chaotic functioning ($r = -.081$, $p < .05$), indicating that higher balanced flexibility corresponded to slightly lower chaotic tendencies. Rigid and chaotic profiles were positively related ($r = .201$, $p < .001$), suggesting that in some families, higher rigidity may coexist with elements of instability or inconsistent flexibility (again highlighting that these patterns can overlap rather than form strict opposites).

Finally, the FDDDU indicator (more planned, bounded, and purpose-driven digital device use) showed a consistent "protective" correlation pattern. FDDDU was negatively associated with work-to-home spillover ($r = -.209$, $p < .001$), suggesting that better-regulated device use corresponds to less perceived interference from work into home life. FDDDU was also moderately and positively related to life satisfaction ($r = .428$, $p < .001$), indicating that individuals with more regulated digital engagement reported higher subjective well-being. In the family domain, FDDDU correlated positively with balanced flexibility ($r = .337$, $p < .001$) and showed a small positive association with rigid family functioning ($r = .122$, $p < .001$). The relationship between FDDDU and chaotic family functioning was small and non-significant ($r = -.046$, $p > .05$), suggesting that regulated device use did not meaningfully covary with chaotic family patterns at the bivariate level.

These correlations support the expected directions for the central constructs: work-to-home strain aligns with lower well-being and more chaotic/rigid tendencies, whereas higher life satisfaction aligns strongly with balanced family flexibility and with more regulated digital device use.

The mediation model showed that negative work-to-home spillover had a significant total effect on life satisfaction ($b = -0.546$, $p < .001$), indicating that higher spillover was associated with lower life satisfaction overall. When the mediators were entered simultaneously, the direct effect remained significant ($b = -0.360$, $p < .001$), demonstrating partial mediation.

Effect type	Path	*b*	SE	*z*	*p*	95% CI LL	95% CI UL
Direct effect	Work negatively influencing home → Satisfaction With Life	-0.360	0.048	-7.482	< .001	-0.454	-0.265
Indirect effect	Work negatively influencing home → Balanced Flexibility Family → Satisfaction with Life	-0.075	0.023	-3.308	< .001	-0.119	-0.031
Indirect effect	Work negatively influencing home → Rigid Family → Satisfaction with Life	-0.015	0.007	-1.999	.046	-0.029	-0.0003
Indirect effect	Work negatively influencing home → Chaotic Family → Satisfaction with Life	-0.013	0.009	-1.493	.136	-0.031	0.004

Effect type	Path	*b*	SE	*z*	*p*	95% CI LL	95% CI UL
Indirect effect	Work negatively influencing home → FDDDU → Satisfaction with Life	-0.084	0.018	-4.719	< .001	-0.118	-0.049
Total effect	Work negatively influencing home → Satisfaction with Life	-0.546	0.054	-10.103	< .001	-0.652	-0.440
Total indirect effect	Work negatively influencing home → Satisfaction with Life (via all mediators)	-0.187	0.032	-5.809	< .001	-0.250	-0.124

Note. Unstandardized coefficients (b). Delta method standard errors; normal-theory confidence intervals; ML estimator. FDDDU = Frequency and Duration of Digital Device Use.

Table 3. Mediation analysis predicting life satisfaction from negative work-to-home spillover (N = 735)

The combined indirect effect across all mediators was significant (b = −0.187, p < .001), meaning that a substantial portion of the association between spillover and life satisfaction was transmitted through the proposed mechanisms. Examining specific indirect effects, two pathways were clearly supported. First, spillover predicted lower life satisfaction indirectly via balanced family flexibility (b = −0.075, p < .001), suggesting that greater spillover is linked to lower balanced flexibility, which in turn relates to reduced well-being. Second, spillover also had a significant indirect effect through regulated digital device use (FDDDU) (b = −0.084, p < .001), consistent with the interpretation that spillover is associated with less bounded/purpose-driven device use, which then relates to lower life satisfaction.

A smaller indirect pathway through rigid family functioning reached statistical significance (b = −0.015, p = .046), but the indirect effect through chaotic family functioning was not significant (b = −0.013, p = .136), as its confidence interval included zero. Overall, the pattern indicates that the spillover–life satisfaction link is explained primarily through reduced balanced flexibility and less regulated digital device use, while rigid functioning contributes weakly and chaotic functioning does not carry a reliable indirect effect in this model.

Residual covariances were estimated among the mediators to account for shared variance not explained by the predictor. Results indicated a positive and statistically significant residual covariance between Balanced Flexibility and Rigid Family (estimate = 0.135, SE = 0.015, z = 8.726, p < .001, 95% CI [0.104, 0.165]), suggesting that—net of the

model—higher balanced flexibility tended to co-occur with higher rigidity at the residual level. In contrast, the residual covariance between Balanced Flexibility and Chaotic Family was negative but not significant (estimate = −0.025, SE = 0.015, z = −1.694, p = .090, 95% CI [−0.053, 0.004]), indicating no reliable residual association between these two patterns once other model relations were taken into account.

A significant positive residual covariance emerged between Rigid Family and Chaotic Family (estimate = 0.080, SE = 0.016, z = 4.929, p < .001, 95% CI [0.048, 0.112]), implying that rigid and chaotic characteristics shared additional common variance beyond the predictor effects.

Regarding technology-use regulation, FDDDU showed a moderate positive residual covariance with Balanced Flexibility (estimate = 0.218, SE = 0.026, z = 8.286, p < .001, 95% CI [0.167, 0.270]) and a smaller but significant positive residual covariance with Rigid Family (estimate = 0.112, SE = 0.028, z = 4.014, p < .001, 95% CI [0.058, 0.167]). This pattern suggests that, beyond the modeled paths, more regulated/purpose-driven device use tended to align with higher balanced flexibility and, to a lesser extent, with rigidity. Finally, the residual covariance between Chaotic Family and FDDDU was essentially zero and not significant (estimate = −0.003, SE = 0.027, z = −0.119, p = .905, 95% CI [−0.057, 0.051]), indicating no meaningful residual linkage between chaotic family functioning and regulated device use.

The structural model estimated the direct effects of negative work-to-home spillover on life satisfaction, both directly and indirectly via family flexibility profiles and regulated digital device use (FDDDU), while controlling for gender and age. Table 4 reports the unstandardized path estimates (ML estimator) with delta-method standard errors and normal-theory 95% confidence intervals.

Path	***b***	**SE**	***z***	***p***	**95% CI LL**	**95% CI UL**
Balanced Flexibility Family → Satisfaction with Life	0.593	0.052	11.445	< .001	0.492	0.695
Rigid Family → Satisfaction with Life	-0.125	0.046	-2.742	.006	-0.215	-0.036
Chaotic Family → Satisfaction with Life	-0.068	0.043	-1.566	.117	-0.153	0.017
FDDDU → Satisfaction with Life	0.206	0.026	8.001	< .001	0.156	0.257
Work negatively influencing home → Satisfaction with Life	-0.360	0.048	-7.482	< .001	-0.454	-0.265
Work negatively influencing home →	-	0.037	-3.455	<	-0.198	-0.055

Path	*b*	SE	*z*	*p*	95% CI LL	95% CI UL
Balanced Flexibility Family	0.126			.001		
Work negatively influencing home → Rigid Family	0.118	0.040	2.922	.003	0.039	0.197
Work negatively influencing home → Chaotic Family	0.198	0.040	4.946	< .001	0.119	0.276
Work negatively influencing home → FDDDU	-0.405	0.069	-5.843	< .001	-0.541	-0.269
Gender → Work negatively influencing home	0.002	0.076	0.027	.978	-0.148	0.152
Age → Work negatively influencing home	0.001	0.002	0.269	.788	-0.003	0.005
Gender → Balanced Flexibility Family	-0.101	0.076	-1.334	.182	-0.250	0.047
Age → Balanced Flexibility Family	0.005	0.002	2.222	.026	0.001	0.009
Gender → Rigid Family	-0.017	0.084	-0.205	.837	-0.181	0.147
Age → Rigid Family	0.001	0.002	0.557	.578	-0.003	0.006
Gender → Chaotic Family	0.057	0.083	0.681	.496	-0.106	0.219
Age → Chaotic Family	0.002	0.002	1.105	.269	-0.002	0.007
Gender → FDDDU	-0.549	0.144	-3.814	< .001	-0.831	-0.267
Age → FDDDU	-0.003	0.004	-0.662	.508	-0.010	0.005
Gender → Satisfaction with Life	-0.123	0.096	-1.285	.199	-0.312	0.065
Age → Satisfaction with Life	-0.001	0.003	-0.577	.564	-0.007	0.004

Note. Unstandardized estimates (b). Delta method standard errors; normal-theory confidence intervals; ML estimator. FDDDU = Frequency and Duration of Digital Device Use.

Table 4. Structural model path coefficients predicting life satisfaction and mediators (N = 735)

Life satisfaction was positively predicted by Balanced Flexibility (b = 0.593, SE = 0.052, z = 11.445, p < .001), and by FDDDU (b = 0.206, SE = 0.026, z = 8.001, p < .001). In contrast, Rigid Family was a significant negative predictor of life satisfaction (b = −0.125, SE = 0.046, z = −2.742, p = .006). The effect of Chaotic Family on life satisfaction was negative but not statistically significant (b = −0.068, SE = 0.043, z = −1.566, p = .117). Importantly, negative work-to-home spillover retained a robust direct negative association with life satisfaction (b = −0.360, SE = 0.048, z = −7.482, p < .001), indicating

that spillover predicted lower life satisfaction even after accounting for the mediators and covariates.

Regarding the mediators, higher work-to-home spillover predicted lower Balanced Flexibility (b = −0.126, SE = 0.037, p < .001), but higher Rigid Family (b = 0.118, SE = 0.040, p = .003) and higher Chaotic Family (b = 0.198, SE = 0.040, p < .001). Work-to-home spillover also predicted lower FDDDU (b = −0.405, SE = 0.069, p < .001), suggesting that greater spillover was associated with less regulated, less bounded device use.

For covariates, age showed a small positive association with Balanced Flexibility (b = 0.005, SE = 0.002, p = .026), while gender significantly predicted FDDDU (b = −0.549, SE = 0.144, p < .001). All other covariate paths (gender/age predicting spillover, rigid, chaotic, and life satisfaction) were not significant.

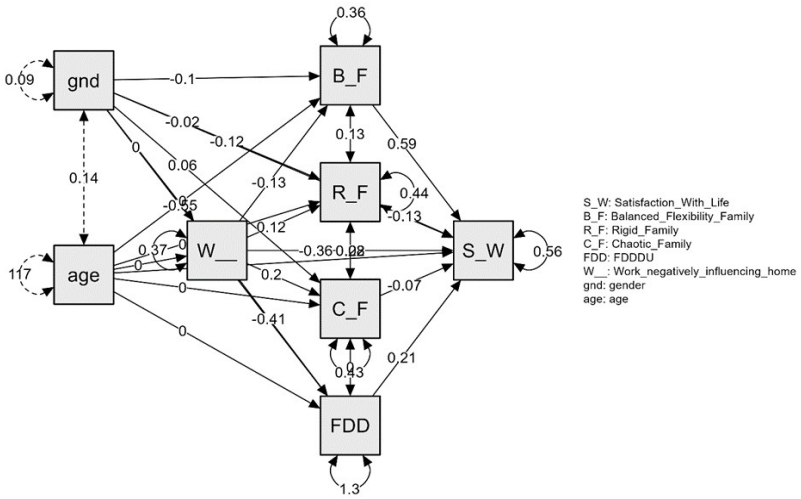

Figure 1. Structural path model linking negative work-to-home spillover to life satisfaction via family flexibility profiles and regulated digital device use (covariates: gender, age)

Figure 1 summarizes the tested path model linking negative work-to-home spillover to life satisfaction, while accounting for the joint roles of family flexibility profiles and regulated digital device use (frequency and duration), and controlling for gender and age. In the model, negative work-to-home spillover is positioned as the key predictor, life satisfaction as the primary outcome, and four parallel mediating mechanisms are specified: balanced family flexibility, rigid family functioning, chaotic family functioning, and frequency and duration of digital device use. The diagram also allows the mediators to covary, reflecting the fact that family flexibility patterns and device-

use regulation are related processes that can operate simultaneously rather than in isolation.

The figure visually reinforces the core pattern found in the results. First, negative work-to-home spillover shows a clear, direct negative association with life satisfaction, indicating that when work demands intrude into home life (e.g., irritability, fatigue, reduced availability), people report lower overall satisfaction with life even after accounting for family functioning and digital regulation. Second, the model clarifies how this spillover translates into lower life satisfaction through multiple pathways. Higher negative spillover is associated with lower balanced family flexibility and lower regulation of digital device use, and both of these are linked to higher life satisfaction—meaning they function as protective channels. In contrast, negative spillover is associated with higher rigid family functioning and higher chaotic family functioning. Of these, rigid functioning is tied to lower life satisfaction, supporting a risk pathway; chaotic functioning trends in the same negative direction but does not contribute uniquely once the other mediators are considered.

The covariates in Figure 1 help interpret the model in a nuanced way. Gender and age do not meaningfully predict negative work-to-home spillover or life satisfaction in this model, suggesting that the central spillover–wellbeing link is not simply a demographic artifact. However, gender is related to frequency and duration of digital device use, indicating systematic differences in how tightly digital time is regulated. Age shows a small positive association with balanced family flexibility, suggesting slightly more balanced flexibility among older participants. Figure 1 maps the study's theoretical logic onto the empirical tests and, as such, provides a direct response to the research questions.

First, negative work-to-home spillover is significantly associated with lower life satisfaction, as indicated by a substantial negative total effect and a statistically significant negative direct effect that remains after accounting for the mediating mechanisms.

Second, family flexibility contributes to explaining this association, but in an asymmetric manner across profiles. Specifically, lower balanced family flexibility and higher rigid family functioning carry statistically significant indirect effects linking spillover to reduced life satisfaction, whereas chaotic family functioning does not yield a statistically reliable indirect pathway once the full set of mediators is considered simultaneously.

Third, regulation of digital device use (frequency and duration) functions as an additional explanatory mechanism. Higher negative work-to-home spillover is associated with poorer regulation of device

use, which in turn is related to lower life satisfaction, supporting a distinct and significant indirect effect through this pathway.
Overall, the model depicted in Figure 1 indicates that work-to-home interference undermines life satisfaction both directly and indirectly, primarily by reducing balanced family flexibility and weakening the regulation of everyday digital device use, with rigid family functioning operating as an additional risk-related conduit.

Discussion

The present findings extend classic spillover research by showing that negative work-to-home spillover is robustly associated with lower life satisfaction, and that this association operates through multiple family- and technology-related pathways rather than through a single mechanism. In line with longitudinal and daily-spillover evidence that experiences at work "carry over" into the home domain (Leiter & Durup, 1996) and shape broader wellbeing outcomes (Lourel et al., 2009; Rodríguez-Muñoz et al., 2014), participants reporting higher negative spillover also reported substantially lower life satisfaction. Importantly, the total effect remained partly direct, indicating that spillover may diminish wellbeing through additional routes not modeled here (e.g., fatigue, rumination, depleted recovery), consistent with the broader work–home interface literature.
Although some spillover studies focus on job satisfaction "flowing" into family life—often emphasizing facilitating conditions such as integration preferences (Ilies et al., 2009)—the current results highlight the cost side of the interface: when work strains intrude into home life, overall life evaluation suffers. This aligns with findings linking negative spillover to perceived stress and lower satisfaction (Lourel et al., 2009), and to the notion that the work–home boundary is a central resource-management system, where interference undermines recovery and subjective wellbeing (Hyland & Prottas, 2017; Lott, 2020). Taken together, the pattern supports a "spillover-as-strain" interpretation: interference originating in work spills into the private sphere and is reflected in lower global wellbeing.
A key contribution of the present model is the simultaneous test of multiple family flexibility patterns. The findings suggest that balanced family flexibility is protective and functions as a meaningful mediator: higher spillover is associated with lower balanced flexibility, and lower balanced flexibility is, in turn, strongly related to lower life satisfaction. This is consistent with theory that flexible, adaptive family functioning supports coping, coordination, and emotional regulation in the face of external demands—thereby buffering wellbeing when work pressure rises.

By contrast, rigid family functioning emerged as an additional (but smaller) risk pathway: spillover predicted higher rigidity, and rigidity predicted lower life satisfaction. This pattern is compatible with the idea that when work stress intrudes, families may respond by tightening rules, routines, and roles, which can reduce autonomy and supportive responsiveness. In other words, spillover may shift family adaptation toward "control" rather than "flexibility," which then contributes to diminished wellbeing.

Chaotic family functioning did not contribute a statistically reliable indirect pathway in the full mediation model. This does not imply chaos is irrelevant—its bivariate associations with spillover and life satisfaction were in the expected direction—but rather suggests that, when modeled alongside balanced and rigid patterns (and the digital pathway), chaos does not uniquely explain variance in life satisfaction. One interpretation is that chaotic functioning overlaps with other mediators (shared variance) and may be less central than the loss of balance and the increase in rigidity for explaining why spillover translates into lower life satisfaction.

Beyond family functioning, the analysis identified regulation of digital device use (frequency and duration) as a statistically significant mediator. This result directly resonates with research on technology-driven spillovers, where communication technologies extend work demands into home time, increase availability pressure, and intensify boundary permeability (Benlian, 2020; Berkowsky, 2013; Wajcman et al., 2010). The current findings suggest that when negative spillover is high, individuals report less regulated device use, which is then associated with lower life satisfaction. This aligns with work showing that ICT use can be "help or harm," depending on how it reshapes boundaries and recovery (Wang et al., 2019).

The relevance of the digital pathway is also consistent with more recent evidence emphasizing boundary "work" and the role of flexibility/permeability across domains (Hyland & Prottas, 2017). Under flexible arrangements (including working from home), spillovers can increase when norms and expectations encourage constant connectivity (Bölingen et al., 2023). This helps explain why, even when flexibility is available, employees may struggle to "switch off," especially if flexibility is paired with high cognitive spillover and persistent digital access (Lott, 2020). In this context, device-use regulation can be interpreted as a practical marker of boundary control: better regulation may indicate stronger capacity to protect recovery time, while poorer regulation may reflect "always-on" dynamics.

Finally, emerging research suggests that digital skills may shape how people manage these digital boundaries. Christensen and Treas (2024)

argue that digital boundary work—and spillover—can vary across contexts and competencies. This opens an important possibility for the present model: the digital pathway may be stronger among individuals facing high connectivity demands without adequate boundary-management strategies, or weaker among those with higher digital skills and deliberate practices.

The current results are particularly relevant for contemporary work arrangements characterized by hybrid and remote work and expanded ICT use. Evidence indicates that work-from-home settings can "open doors" for spillover, contingent on organizational practices and boundary norms (Bölingen et al., 2023), while remote-work job satisfaction is partly explained by spillover and work–life balance dynamics (García-Salirrosas et al., 2023). The present model complements this literature by showing that the negative spillover route is tied to lower life satisfaction via both family functioning (especially reduced balanced flexibility) and digital self-regulation.

Although this study focused on work-to-home interference, prior research also emphasizes bidirectional processes (Du et al., 2018). From a work–home resources perspective, depleted resources at home can spill back into work, reinforcing strain cycles. The present findings—especially the strong role of balanced flexibility—suggest that future models should examine whether adaptive family functioning not only protects life satisfaction but also prevents subsequent family-to-work spillover, creating upward resource spirals.

In the present model, gender and age did not show broad, consistent associations with the core outcomes once spillover and mediators were included, except for a significant gender effect on regulation of device use and a small age effect on balanced flexibility. This mixed pattern is compatible with the broader literature: gender differences in spillover can vary across life stages, parenting demands, and role expectations (Lin & Burgard, 2018). The implication is that demographic differences may emerge more clearly when additional contextual variables are modeled (e.g., caregiving load, occupational role, remote-work intensity, organizational support).

Several limitations should be considered when interpreting these findings. First, the study is cross-sectional, and therefore the temporal ordering implied by the mediation model cannot be empirically confirmed. Although the tested pathways are theoretically plausible, reverse or reciprocal dynamics remain possible—for example, lower life satisfaction may heighten the salience of spillover experiences or weaken perceived boundary control. To strengthen causal inference, future research should employ longitudinal and daily-diary designs that can capture within-person fluctuations and recovery processes over

time (Leiter & Durup, 1996; Benlian, 2020). Second, all constructs were assessed via self-report, which may inflate associations through shared method variance and common appraisal tendencies. Multi-source measurement strategies would improve robustness, such as combining self-reports with partner ratings of family functioning, supervisor- or register-based indicators of workload, and passive or logged indicators of technology use that more directly reflect frequency and duration patterns. Third, the present operationalization focused on negative work-to-home spillover, without assessing positive spillover or facilitation processes. This is a substantive constraint because positive spillover can meaningfully shape wellbeing and job satisfaction, particularly in supportive contexts where integration is beneficial rather than intrusive (Ilies et al., 2009; Rodríguez-Muñoz et al., 2014; García-Salirrosas et al., 2023). Finally, spillover processes are context-dependent: occupational roles, organizational culture, and work arrangements (including remote or hybrid formats) can all condition the intensity and meaning of boundary experiences. Prior evidence indicates that supportive arrangements and culture shape spillover patterns (Sok et al., 2014), and that working from home may modify boundary permeability in contingent ways (Bölingen et al., 2023); accordingly, generalization beyond the present context should be approached cautiously.

These limitations directly inform several future directions. A priority is the adoption of longitudinal and daily-diary approaches to test short-term spillover mechanisms and to clarify whether regulation of digital device use operates primarily as a same-day pathway or reflects longer-term habits linked to wellbeing (Benlian, 2020; Lott, 2020). Future models should also explicitly incorporate bidirectionality and crossover processes by adding family-to-work spillover and testing resource cycles, as well as potential crossover effects into partner wellbeing and family climate (Du et al., 2018; Rodríguez-Muñoz et al., 2014). Conceptually, it will be important to distinguish flexibility from permeability: boundary scholarship suggests that flexibility is not uniformly protective when it increases permeability and after-hours reachability, so studies should separate formal flexibility (policies) from experienced boundary control (everyday practices), especially in hybrid and remote environments (Hyland & Prottas, 2017; Bölingen et al., 2023). Given the growing relevance of digital boundary work, future research should integrate digital skills and boundary-management competencies as potential moderators, which may clarify when ICT use amplifies versus mitigates spillover and work–life balance strain (Christensen & Treas, 2024; Wang et al., 2019). In addition, broader “digital ecology” indicators—such as after-hours

messaging norms, availability expectations, and platform-specific demands—should be included to better specify technology-driven spillover processes (Berkowsky, 2013; Wajcman et al., 2010), alongside macro-level patterns linking internet usage to job attitudes in the digital era (Shao, 2025). Finally, organizational culture and support should be modeled as upstream predictors, as supportive arrangements can reduce negative spillover and enable healthier boundary regulation; multilevel designs are particularly well-suited to testing how unit-level norms interact with individual strategies and family functioning (Sok et al., 2014).

Conclusions

This study clarifies how negative work-to-home spillover relates to life satisfaction among tech-savvy STEM professors operating in a digitally saturated academic context. Higher levels of negative spillover were associated with lower life satisfaction, and this association remained significant even after accounting for the proposed mediators, indicating a robust direct pathway.

At the same time, the findings support a multi-path explanation. Balanced family flexibility emerged as a key protective mechanism: greater spillover was linked to lower balanced flexibility, which in turn predicted higher life satisfaction, yielding a significant indirect effect. Rigid family functioning also contributed a smaller but statistically significant indirect pathway, suggesting that spillover may foster more inflexible family patterns that modestly undermine wellbeing. By contrast, chaotic family functioning did not transmit the spillover effect to life satisfaction in the full model, indicating that not all maladaptive flexibility patterns operate as reliable mechanisms in this sample.

Beyond family dynamics, regulation of digital device use—captured through the management of frequency and duration—represented an additional and independent pathway. Furthermore, the finding on the role of the frequency and duration of digital device use can also be interpreted through a legal–cybersecurity lens of boundary management and digital hygiene, given that intensified technology use may increase exposure to cyber risks, raise national security concerns, and heighten tensions around the protection of fundamental rights in digital contexts (Apachiței, 2021; Apachiței & Sîrcu, 2023; Apachiței, 2024). Greater spillover was associated with poorer regulation of device use, which was, in turn, related to lower life satisfaction. This finding reinforces the idea that boundary processes for tech-savvy STEM professors are increasingly hybrid: psychological strain crosses into family life not only through relational and systemic family

functioning, but also through everyday digital routines that may either protect recovery time or extend work demands into the home sphere.
Overall, the model suggests that negative work-to-home spillover reduces life satisfaction directly and indirectly, primarily by weakening balanced family flexibility and by loosening control over daily digital device use, with rigid family functioning adding a smaller risk channel. These results highlight practical priorities for interventions aimed at protecting wellbeing in high-demand, high-connectivity academic environments: reducing spillover at the source (workload and after-hours expectations), strengthening balanced family flexibility, and supporting concrete digital boundary practices that preserve recovery and family time.

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