Received 18 October 2025
Revised 16 December 2025
27 February 2026
28 February 2026
Accepted 2 March 2026

Working bodies, thinking minds: embodied cognition and attention in hybrid project work

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Abstract

Purpose – This study aims to examine how embodied cognition and technological mediation shape attentional stability in hybrid project environments. It explores how temporal rhythms, ICT complexity and spatial context influence moment-to-moment cognitive composure during project work.

Design/methodology/approach – A qualitative multiple-case study was conducted with three experienced project managers. Wearable EEG data – capturing "EEG Calmness" as an indicator of attentional regulation – were integrated with contextual observations across home and office settings, different times of day and varying levels of ICT complexity. The study adopts an interpretive, ecologically grounded approach rather than hypothesis testing.

Findings – Across cases, attentional stability tended to peak in the morning and decline in the afternoon, with office environments providing greater cognitive buffering than home offices. Meeting difficulty had limited physiological impact, suggesting that experienced managers rely on embodied self-regulation to sustain composure. ICT complexity showed context-dependent effects, indicating that digital saturation interacts with spatial affordances to shape cognitive states.

Research limitations/implications – The small, theoretically sampled set of cases limits generalizability but offers analytic depth. Future research could extend embodied cognition analysis to team-level and longitudinal project dynamics.

Practical implications – Insights highlight the importance of aligning hybrid work practices and digital tool use with workers' cognitive rhythms and spatial affordances.

Social implications – The study underscores the social dimension of cognitive well-being in hybrid work. By demonstrating that attention and composure are co-produced through organizational rhythms, technology and social context, it challenges the individualization of productivity. Promoting collective awareness of cognitive rhythms can reduce inequality between home- and office-based workers and foster more humane work cultures. Encouraging transparency and participatory use of physiological data strengthens trust and inclusiveness. Ultimately, the findings suggest that equitable and sustainable digital work depends not only on technological efficiency but on recognizing embodied, relational and ethical aspects of human attention within organizational life.

Funding: This study was supported by the Vedecká Grantová Agentúra MŠVVaŠ SR a SAV (No. VEGA n. 1/0520/24).

Conflict of interest: The author(s) declared no potential conflicts of interest.

International Journal of Organizational Analysis
Vol. 34 No. 12, 2026
pp. 104-125
Emerald Publishing Limited
1934-8835
DOI 10.1108/IJOA-10-2025-6092

Originality/value – The study advances organizational research by integrating neuroergonomic indicators into qualitative inquiry, offering an ecologically valid view of embodied cognition in hybrid project work. It reframes attention as an organizational resource shaped by temporal, technological and spatial rhythms rather than solely individual traits.

Keywords Embodied Cognition, Attention, Hybrid Work, Neuroergonomics, Organizational Design, Project Management, Digital Collaboration

Paper type Research paper

Introduction

Contemporary projects are situated in increasingly complex and dynamic settings, where conventional, control-based methods of planning and execution frequently struggle to remain effective (Geraldi and Söderlund, 2018). Research highlights that contemporary project management requires adaptation to nonlinear, emergent dynamics driven by globalization, digitization and technological acceleration (Cicmil *et al.*, 2009; Geraldi, Maylor, and Williams, 2011). Saynisch (2010a, 2010b) similarly emphasizes that Project Management Second Order (PM-2) is required to address these challenges, advocating systemic thinking, self-organization and an expanded focus on the cognitive and social dimensions of projects. This perspective positions projects as complex adaptive systems in which leadership, coordination and decision-making must continuously adjust to evolving organizational conditions.

At the same time, a growing body of research highlights that human and relational factors are key predictors of project outcomes. Emotional intelligence, leadership style and psychological competencies often contribute as much or more to project performance as traditional technical planning skills (Müller and Turner, 2010; Turner and Müller, 2005). Recent longitudinal work by O'Connor, Wiewiora, and Spark (2024) further demonstrates that state-level psychological traits – such as tolerance of ambiguity – fluctuate over time and strongly predict team performance and progress. These findings underscore the need for approaches that integrate cognitive, emotional and interpersonal dimensions of project work, particularly in hybrid and distributed settings where team members' sense of presence and coordination is mediated through technology.

Parallel developments in neuroergonomics and embodied cognition suggest that cognitive processes are not solely internal but emerge through continuous interaction between mind, body, tools and environment. A recent systematic review shows that neurophysiological methods (e.g. heart rate variability, EEG) are gaining recognition as tools for assessing mental workload in real-world, *in situ* work environments (Sano *et al.*, 2018; Wascher *et al.*, 2021). Yet the field remains fragmented – workload is often measured in controlled settings, and few studies explore continuous, moment-by-moment fluctuations within the socio-material fabric of everyday organizational life (Diarra et al, 2025).

Recent developments in mobile neuroergonomics further emphasize the feasibility of capturing cognitive and affective states in real-world environments, allowing researchers to move beyond laboratory constraints (Curtin and Ayaz, 2018).

This article addresses this underexplored dimension by offering a detailed, ecologically valid account of how cognitive and affective states are co-produced through spatial contexts, ICT use and organizational rhythm.

Accordingly, we ask: How do organizational rhythms – spatial, temporal and task-based – shape the embodied cognitive experience of project managers in hybrid work environments? And how can physiological indicators enrich our understanding of the often-invisible forms of agency, adaptation and strain embedded in everyday project work?

To address these questions, we conducted a longitudinal, ecologically situated study of three experienced project managers in a mid-sized European technology firm. Using wearable EEG and biometric sensors, we recorded moment-to-moment indicators of mental relaxation, autonomic arousal and physical stillness across remote and in-office settings. Participants also assessed the subjective difficulty of meetings and intensity of ICT use, enabling a layered view of how temporal, technological and spatial factors interact.

By integrating qualitative case analysis with neuroergonomic evidence, this study contributes to a more human-centred organizational discourse – one attuned to the rhythms, vulnerabilities and capacities of those who labour within increasingly digitized and hybridized project environments. It also illustrates how physiological data can be meaningfully incorporated into organizational case research, offering a methodological pathway for studying embodied cognition in project-based work.

Literature review: Temporal, technological and spatial rhythms of cognition in project work

Embodied cognition and cognitive composure in project management

Organizational and cognitive science research demonstrates that human thought and action emerge from dynamic interactions between mind, body and environment. The perspective of embodied cognition (Varela, Thompson and Rosch, 1991; Sadler-Smith, 2008) posits that perception, attention and emotion are grounded in physical and social experience. Mental composure – traditionally viewed as a trait – is increasingly recognized as a situational physiological state shaped by posture, affect and contextual cues (Styhre, 2004; Brown, Colville and Pye, 2015). Complementing this view, research on cognitive styles highlights stable individual differences in how people structure, process and regulate information in complex task environments, suggesting that attentional orientation reflects both embodied states and enduring cognitive preferences (Cool and Van den Broeck, 2007). Contemporary empirical work also shows that embodied states actively shape interpretation and sensemaking in technology-intensive settings, reinforcing the view that cognition is enacted through bodily engagement with tools and environments (Treem, Leonardi, and van Dorp, 2023; Styhre, 2011).

Within project management research, these embodied processes directly influence performance. Emotional intelligence, attention regulation and self-awareness predict project success alongside technical competence (Müller and Turner, 2010). More recent longitudinal research demonstrates that tolerance of ambiguity fluctuates dynamically and predicts project progress and well-being, highlighting the fluid and context-dependent nature of cognition in project work (O'Connor, Wiewiora and Spark, 2024). The present study conceptualizes cognitive composure as a moment-to-moment physiological state that reflects an individual's capacity to maintain attentional stability across shifting temporal, technological and environmental conditions. Measured through EEG Calmness, this construct functions as an indicator of embodied self-regulation during knowledge-intensive work. Prior neuroergonomic research shows that EEG alpha and theta activity are robust markers of mental workload and sustained attention (Parasuraman and Wilson, 2008; Wascher *et al.*, 2021), providing an ecologically valid basis for understanding how calmness supports decision-making and leadership in complex project environments.

Hybrid project work and distributed cognition

Recent scholarship highlights that contemporary project work is increasingly conducted in hybrid configurations, combining remote and co-located collaboration, digitally mediated coordination and fluid spatial arrangements. Hybrid project environments intensify existing

project characteristics – such as temporal urgency, interdependence and uncertainty – while adding new layers of digital complexity and reduced embodied co-presence. Research on distributed and hybrid project teams shows that digital collaboration tools fundamentally reshape coordination, leadership and sensemaking processes (Geraldi and Söderlund, 2018; O'Connor *et al.*, 2024; Pereira *et al.*, 2025). Building organizational strategies that integrate technology and workplace culture is foundational for effective management and well-being in remote and hybrid work, underscoring how digital contexts restructure roles, norms and attention patterns that project practitioners must navigate (Reshma, 2025).

Unlike functional or line managers, project managers typically exercise influence through temporary authority, relational coordination and ongoing negotiation rather than formal hierarchy. In hybrid settings, this role becomes more cognitively and emotionally demanding, as attention must be continuously regulated across meetings, platforms and spatial contexts. Recent project management literature emphasizes that hybrid and digitally intensive project environments increase cognitive fragmentation, coordination load and the need for adaptive leadership practices (Tarafdar *et al.*, 2019; Sørensen *et al.*, 2021).

Furthermore, organizational approaches that strengthen participative decision-making and social capital have been shown to buffer coordination strain and enhance sustainable organizational development, particularly under digitally mediated conditions (Kumar and Gupta, 2023). Yet empirical research has rarely examined how these conditions are experienced at the embodied, moment-to-moment level of project work. By focusing explicitly on project managers rather than managers in general, the present study responds to calls for more human-centred and process-sensitive approaches in contemporary project studies. It positions embodied cognition as a critical lens for understanding how hybrid project environments shape attentional stability, self-regulation and professional practice.

Temporal rhythms and cognitive performance

Human cognition is shaped by predictable temporal rhythms arising from both biological cycles and organizational routines. Chronobiological studies demonstrate systematic variations in alertness and working memory across the day, with performance typically peaking in the morning and declining towards the afternoon (Czeisler *et al.*, 1986; Monk and Folkard, 2020). Evidence from large-scale behavioural data sets (Golder and Macy, 2011) and EEG-based research (Facer-Childs, Boiling and Balanos, 2018) further confirms diurnal patterns in mood, attention and cognitive stability. In project settings – often marked by extended work hours, time pressure and cross-time-zone collaboration – these temporal dynamics may influence decision quality and vulnerability to cognitive fatigue (Sørensen *et al.*, 2021). However, project management research has rarely examined how time-of-day variations intersect with hybrid work arrangements and digitally mediated collaboration. This study addresses this gap by examining how temporal rhythms manifest in the embodied, day-to-day experiences of three project managers.

Digital technologies further shape these rhythms by structuring how attention is distributed across tasks and tools. Cognitive load theory (Sweller, 1988) suggests that ICT complexity – defined as the extent of parallel digital engagement, information switching and coordination required – can elevate extraneous load, fragment attention and diminish cognitive composure. Empirical research supports these dynamics: frequent switching between tools and persistent notifications increase perceived workload and disrupt focus (Mark and Voida, 2012; Mirbabaie *et al.*, 2020). Nakayama and Chen (2022) further shows that digital saturation weakens emotional regulation, whereas coherent and well-structured tool ecosystems help mitigate overload. At the same time, integrated platforms might enhance situational awareness when cognitive demands are appropriately structured. In this

study, ICT complexity is therefore treated as a context-sensitive descriptor of meeting types, ranging from single-platform communication to multi-tool coordination, enabling qualitative examination of how technological mediation interacts with temporal rhythms to shape attentional stability.

Spatial context and cognitive scaffolding in hybrid work

Spatial context influences cognition through its physical, sensory and social affordances. Office environments typically offer structured rhythms – shared routines, ambient cues and collective expectations – that help sustain attentional focus. Home settings, while providing autonomy and flexibility, can introduce greater variability and potential distraction (Choudhury, Foroughi and Larson, 2020). Prior research demonstrates that spatial design affects cognitive and emotional states (Knight and Haslam, 2010; Appel-Meulenbroek *et al.*, 2016), shaping how individuals manage attention over the course of the workday.

From an embodied cognition standpoint, cognitive processes emerge through ongoing interaction with material surroundings (Clarke, 2010). Home environments may support comfort and self-paced work yet lack the regulatory cues that structure transitions, breaks and interpersonal coordination. In contrast, office settings provide environmental consistency and social scaffolding, although sometimes at the cost of personal agency. Recognizing these differential affordances is essential for understanding hybrid project work, where professionals shift between spaces that variously support – or challenge – their attentional regulation.

To illustrate these structuring influences, Figure 1 adapts Lewin's (1936) life-space model to map a project manager's progression (P → G) through key milestones (e.g. M1, M2, M3 […] M6), highlighting how spatial and institutional constraints channel cognitive effort.

Conceptual model and research focus

Building on these insights, the study investigates how temporal rhythms, ICT complexity and work environment shape EEG Calmness as an embodied indicator of attentional stability in hybrid project work. Rather than treating these constructs as variables in a formal statistical model, we use them as sensitizing concepts that orient our qualitative, multiple-case analysis. Temporal rhythms capture fluctuations in attentional stability across the workday; ICT complexity reflects the intensity of digital engagement; and work environment (home versus

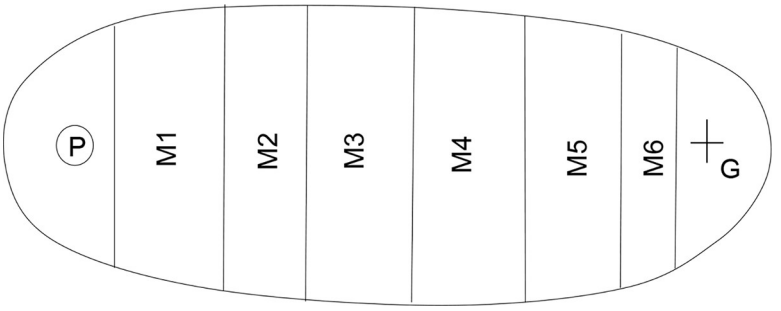

Figure 1. Adaptation of Lewin's (1936) life-space model illustrating a project manager's progression from (*p* = project start) towards the project goal (G = project goal) through successive milestones (M1–M6 = project milestones) (Lewin, 1936, p. 48 – information adapted to the context of this study)

office) represents the spatial and organizational affordances that scaffold or challenge cognitive regulation.

Together, these concepts provide an interpretive framework that connects neuroergonomics with organizational and project management scholarship. The study examines the following research question:

RQ1: How do temporal rhythms, ICT complexity and work environment influence EEG-based calmness – an indicator of embodied cognitive composure – during hybrid project work?

Rather than advancing formal hypotheses, the study develops guiding propositions drawn from chronobiology, cognitive load theory and neuroergonomics: that (a) attentional stability may be higher in the morning, (b) ICT complexity may challenge composure, particularly in less structured environments and (c) home and office settings may offer different forms of cognitive scaffolding.

These propositions sensitize the analysis to emergent patterns while allowing inductive theorization about how project managers navigate the temporal, technological and spatial demands of hybrid work.

Methodology

Research design

This study employed an ecologically grounded, multiple-case design informed by principles of embodied cognition and neuroergonomics. Its aim was to examine how temporal, technological and spatial dynamics shape the embodied cognitive experiences of project managers working in hybrid environments. Guided by Lewin's (1936) concept of life space – which conceptualizes behaviour as emerging from ongoing person - environment interaction – the design emphasizes ecological validity rather than experimental control. The study follows an interpretivist epistemology, viewing cognition as situated and enacted.

The study follows an idiographic, dense longitudinal approach, generating rich within-case accounts of attentional rhythms across changing work contexts. Rather than seeking statistical representativeness, the design captures temporal and situational patterns of cognition in real-world project work (Facer-Childs, Boiling and Balanos, 2018; Langley, 1999). The measurement episode served as the primary unit of analysis, enabling repeated observations within each case. Across the three cases, 70 naturalistic sessions were collected, systematically varying by time of day, work environment (home vs office) and ICT complexity. These repeated, contextually embedded observations offer fine-grained insight into how embodied cognition unfolds during everyday project work.

Participants and context

Three experienced project managers (two male, one female) from a mid-sized European technology firm (Organization ξ) participated in the study on a voluntary basis. Participants were selected through purposive sampling, with selection criteria emphasizing (a) substantial professional experience, (b) established trust that would permit deep and sustained access and (c) willingness to engage in longitudinal physiological monitoring. Although the sample is small, it aligns with Eisenhardt-inspired multiple-case designs in which a limited number of theoretically relevant cases provides analytic depth and meaningful cross-case comparison (Eisenhardt, 1989; Gehman *et al.*, 2018). Variation in the participants' cognitive-affective orientations – from pragmatic stability to adaptive empathy – further enriched interpretive contrast across cases.

Data collection took place between March 2022 and July 2023, spanning seasonal and organizational cycles. This extended timeframe enabled the identification of recurring cognitive patterns across diverse work demands and contexts. Table 1 presents demographic, professional and psychological profiles of the participants, along with key physiological observations generated through the study.

Data collection and analysis

To complement qualitative observations, neurophysiological data were gathered using the MUSE BSB 7 wearable EEG headset, a validated instrument for ecological field research (Hayes and Magne, 2024). These measures functioned as embedded evidence, supporting rather than determining the qualitative analysis. The device captured three primary indicators: EEG Calmness (%) as a proprietary alpha/theta ratio reflecting momentary attentional stability and mental relaxation; heart rate (bpm) as an index of autonomic arousal derived from photoplethysmography (PPG); and Movement Calm State (%) as a proxy for embodied composure measured via inertial motion sensors. Together, these metrics provided physiological traces of cognitive calmness, understood as a state of focused, regulated engagement under varying contextual demands (Parasuraman and Wilson, 2008; Wascher *et al.*, 2021). Each session lasted approximately 30 min, beginning with a brief acclimation period followed by continuous monitoring during natural work activities. Participants proceeded with their tasks uninterrupted, ensuring ecological realism. Ambient conditions – light, temperature and humidity – were tracked to account for potential environmental influences.

To structure comparison across hybrid work conditions, sessions were categorized along three contextual dimensions central to project work. Firstly, to capture diurnal variation, measurement sessions were conducted across morning (08:00–09:00), midday (12:00–13:00) and afternoon (14:00–15:00) intervals. This temporal spread enabled exploration of how cognitive composure fluctuates throughout the workday. Secondly, work environment was coded as home or office: home settings (63% of sessions) were

Table 1. Summary of participant demographic, professional and psychological characteristics

Participant	Age	Gender	Role/Position	Psychological profile	Key physiological observations
A	55	Male	Senior project manager	Pragmatic, disciplined, calm under pressure; prefers structure and predictability	High resting EEG calmness in mornings; minimal HR variability during high-stress meetings
B	42	Male	Project manager	Charismatic, emotionally resilient, strategic thinker under uncertainty	Stable HR and slight EEG calmness increase in office; high strategic empathy and goal orientation
C	36	Female	Strategic project lead	Visionary, empathetic, sensitive to social cues; intuitive and analytical	High EEG and HR variability; EEG calmness peaks in home office during low-intensity meetings

personalized, flexible spaces (approximately 18 m^2) that afforded autonomy but fewer shared cues, whereas office settings (37%) comprised standardized, socially structured environments (approximately 20 m^2) that provided institutional rhythms and environmental scaffolding. Thirdly, ICT complexity captured the intensity of digital tool use during meetings. Low-complexity interactions involved single-platform communication (e.g. voice or video calls), medium complexity included collaborative co-editing tasks, and high complexity involved parallel multitasking across multiple platforms (e.g. Teams, Miro and Trello). These categories reflect increasing technological mediation and anticipated cognitive demand (Sweller, 1988) and served as interpretive anchors for analyzing embodied cognitive experience across cases.

In addition to the physiological traces, we collected qualitative data to capture how project managers themselves made sense of attentional stability in hybrid work. Firstly, short semi-structured interviews were conducted with each of the three focal participants. These conversations followed the measurement episodes and invited managers to reflect on a) how their attention fluctuated across the workday, b) how home and office environments felt different to work in, c) how they experienced meetings with varying levels of digital complexity and perceived difficulty and d) which bodily strategies they used to stay composed in demanding situations. The interviews were audio-recorded, transcribed *verbatim* and anonymized.

Secondly, two organizational questionnaires were administered at different stages of the research to provide contextual and comparative insight into shared work rhythms, digital demands and perceived autonomy. The first questionnaire, conducted in 2022, captured an organizational snapshot of managerial routines and coordination demands within the focal firm. A second questionnaire was administered in 2026 to a separate, non-overlapping group of managers drawn from a broader organizational pool. This questionnaire was introduced with the specific aim of examining whether patterns identified in the idiographic case analysis were reflected more broadly among managers operating in similar hybrid work contexts. Importantly, the questionnaires were not introduced to "test" or statistically validate the case findings. In line with the idiographic and interpretive design, they served as contextual corroboration – i.e. a complementary organizational lens to examine whether the idiographic patterns identified in the focal cases (diurnal focus shifts, home/office differences and multi-tool strain) resonate with managers operating in comparable hybrid arrangements. The 2026 administration was designed as a non-overlapping snapshot rather than a longitudinal extension of the case sample; its purpose was to strengthen analytic plausibility and boundary conditions, not to infer temporal change. Accordingly, questionnaire results are reported descriptively and interpreted as contextual support alongside interview accounts and physiological traces.

Both questionnaires combined categorical items with short open-ended questions. Respondents identified the most taxing days of the workweek, listed routine and non-routine work activities, specified dominant communication media, named key relational interfaces (e.g. N–1 and N + 1 managers, R&D leaders, project peers), and rated their perceived ability to decline requests ("ability to say no") on a 1–10 scale. The second questionnaire additionally included items that explicitly probed perceived diurnal variation in focus, differences between home and office work, and the cognitive impact of parallel digital tool use, thereby aligning closely with the core constructs examined in the case analysis. Although the questionnaires generated descriptive frequencies, they were not treated as survey instruments for statistical inference. Instead, they functioned as complementary qualitative tools used to situate the idiographic case findings within broader organizational

rhythms, digital workloads and relational structures, thereby strengthening the analytic plausibility of the case-based interpretations.

EEG, heart rate and movement data were exported from the MUSE SDK as time-series files using standard neuroinformatics procedures in MATLAB and Python. Artefacts from motion or signal loss were filtered out, and physiological indicators were averaged for each session. Aligned with the study's qualitative and exploratory orientation, analysis proceeded through three integrated stages: (1) descriptive physiological profiling understand broad temporal, spatial and technological patterns within each case; (2) within-case interpretation, triangulating physiological traces with field notes, contextual observations and participants' subjective assessments, while analyzing interviews and questionnaire responses using thematic analysis (Braun and Clarke, 2006); and (3) cross-case comparison to identify convergences and divergences in how embodied cognition manifested across hybrid work contexts. Throughout, physiological measures were not used for statistical inference but functioned as complementary evidence that deepened understanding of the participants' embodied experiences, enabling a nuanced account of how cognitive and emotional regulation emerges through interactions among workers, tools and environments.

Findings

Diurnal patterns in biophysiological states across home and office contexts

Across the three cases, clear diurnal patterns emerged in cognitive and physiological states, shaped jointly by time of day and work environment. Wearable EEG and biometric sensors revealed fluctuations in mental relaxation (EEG Calmness [%]), heart rate and physical composure (Movement Calm State [%]) during routine tasks in home and office settings. As illustrated in Figure 2, EEG Calmness followed recognizable daily rhythms.

Morning sessions (08:00–09:00) consistently showed higher Calmness levels, whereas early afternoon sessions (14:00–15:00) exhibited marked declines. At home, EEG Calmness typically ranged between 25% and 63%, while office recordings ranged between 34% and 67%, indicating that both circadian tendencies and spatial context influenced attentional stability.

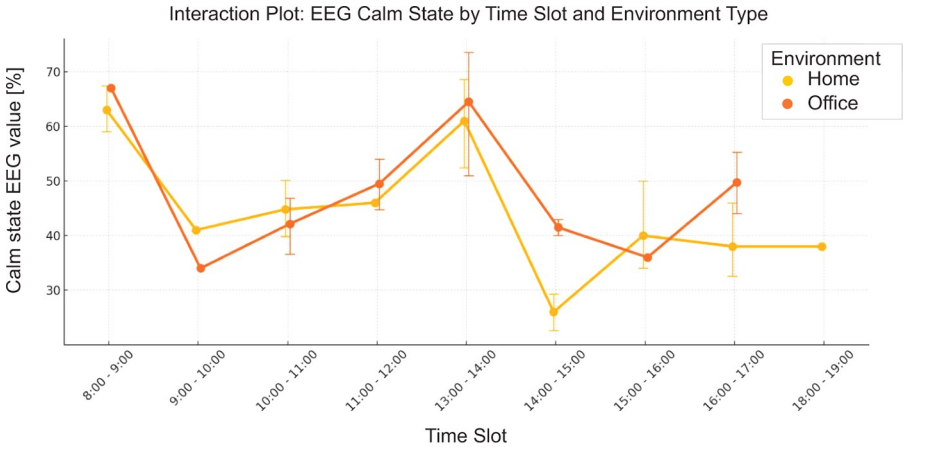

Figure 2. Mean EEG Calmness (%) across time-of-day periods in home and office work environments

These temporal dynamics resonated strongly with participants' subjective accounts. Participant A described that "mornings are when my mind feels the most ordered. I come in with a sense of mental clarity. By early afternoon, the mental clutter builds up – emails, decisions, small adjustments – and my attention becomes more brittle. I can still deliver, but there is definitely more cognitive 'noise' internally". Participant C similarly noted that, with experience, "my emotional reactivity reduced. I still feel tension, but it doesn't spike. My internal responses have smoothed out over the years", suggesting that long-term practice moderates how diurnal strain appears at the experiential level.

Data from both questionnaires further substantiate these temporal patterns. These questionnaire patterns are interpreted as contextual resonance rather than confirmatory evidence, given the study's idiographic case logic. In the 2026 questionnaire ($n = 57$), a clear majority of respondents reported that their ability to stay focused and composed is higher in the morning than in the afternoon, with over half indicating strong agreement. An even larger proportion agreed that mental "noise" and cognitive fatigue accumulate as the day progresses, indicating that diurnal fluctuations in attentional stability are widely experienced among managers. Managers also reported that their workdays are dominated by meetings and digital communication, and that the way the week is scheduled strongly affects mental focus and energy. When these structurally demanding days coincide with afternoon sessions, the convergence of circadian troughs and cumulative decision load likely contributes to the "mental clutter" and attentional brittleness described by participants and reflected in the EEG Calmness declines shown in Figure 2.

Heart rate patterns showed a similar tendency. Home-based sessions showed greater variability (60–80 bpm), whereas office sessions were comparatively stable – likely reflecting the more structured rhythms and lower unpredictability of the office environment.

Physical stillness (Movement Calm State) also varied by time of day in both locations. Participants tended to be more physically composed in the morning, with composure gradually decreasing towards the afternoon.

The diurnal physiological patterns and interview narratives jointly indicate that bodily and cognitive composure follow distinct daily rhythms: mornings are experienced as windows of "mental clarity", whereas afternoons are associated with mounting "noise" and, in some cases, moments where attention "collapse[s] like a wave" during demanding hybrid sessions. These rhythms are not purely biological but are interwoven with how project work and meetings are scheduled across the week. These interlinked physiological, experiential and contextual patterns are summarized in Table 2, which links specific interview excerpts and questionnaire insights to the observed diurnal variations in EEG Calmness.

Project meeting intensity and biophysiological response

Across all three cases, self-reported meeting difficulty – rated on a five-point scale – did not correspond with meaningful variation in EEG Calmness, heart rate or physical activity. Physiological responses remained relatively stable regardless of whether participants perceived a meeting as low or high in cognitive demand.

As shown in Figure 3, EEG Calmness fluctuated only marginally across difficulty levels in both home and office settings. Heart rate and Movement Calm State followed the same pattern, revealing no substantial physiological shifts in response to more challenging meetings.

These findings suggest that experienced project managers draw on well-developed self-regulation practices that enable them to maintain composure even during subjectively demanding interactions. The stability of physiological responses across perceived intensities

Table 2. Interview evidence and contextual data related to temporal rhythms of attention

Participant and excerpt	Focal codes	Related contextual / physiological data	Thematic interpretation
Participant A: "mornings are when my mind feels the most ordered. I come in with a sense of mental clarity. By early afternoon, the mental clutter builds up – emails, decisions, small adjustments – and my attention becomes more brittle"	Morning clarity; afternoon clutter; brittle attention	EEG Calmness higher in morning sessions (08:00–09:00) and lower in early afternoon (14:00–15:00) across home and office contexts	Daily rhythms of composure shaped by cumulative decision load and circadian tendencies
Participant B: "after managing enough high-stakes decisions, my emotional reactivity reduced. I still feel tension, but it doesn't spike. My internal responses have smoothed out over the years"	Experience-based smoothing; reduced spikes in reactivity	No pronounced spikes in heart rate or calmness across time of day in this case, despite reported tension	Professional experience moderates how diurnal strain manifests physiologically and subjectively
Participant C: "One afternoon at home I had a multi-tool workshop… it was too much. I felt my attention collapse like a wave. Later that week in the office, we held the same workshop, and it felt dramatically more stable"	Afternoon overload; attention collapse; office as stabiliser	Calmness lower in afternoon, particularly in high ICT complexity home sessions; more stable in office for similar tasks	Temporal rhythms interact with spatial and digital conditions to produce sharp drops in attentional stability
Questionnaire pattern: Managers most often marked monday, tuesday and thursday as the most taxing days; daily routines dominated by meetings, electronic communication and work with digital applications	Concentration of workload on certain weekdays; interaction- and tool-heavy routines	Many measurement sessions fall on regular working days within these patterns	Weekly scheduling of cognitively demanding activities amplifies afternoon fatigue and diurnal drift

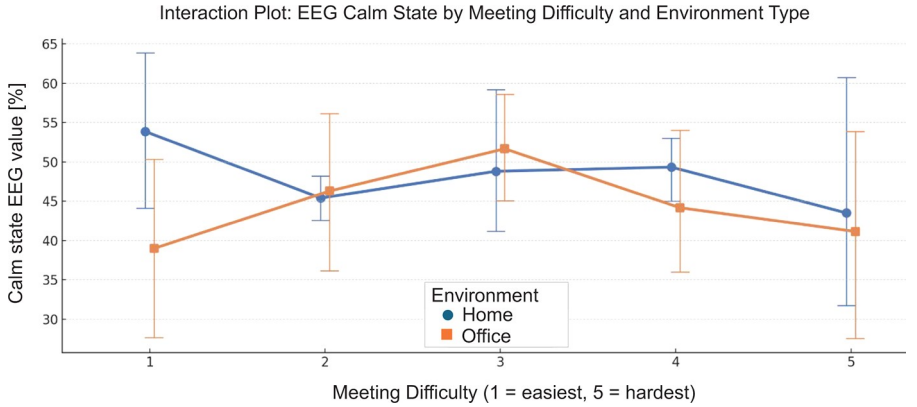

Figure 3. Interaction plot depicting changes in EEG Calmness (%) across self-reported meeting difficulty levels in home and office settings

underscores the role of professional experience and embodied coping routines in supporting attentional stability in project work.

The interviews illuminate what these coping routines look like in practice. Participant A explained:

> I rely on small, embodied cues – straightening my posture, grounding both feet, inhaling before responding. Over the years those became automatic. It's not deliberate anymore; it's part of how I maintain a steady leadership presence. People expect composure from me, and my body has learned to support that.

Participant B described a cognitive strategy more explicitly:

> I manage by mentally separating the layers of the interaction. Sometimes I need to project calm even when I'm uncertain. I don't suppress the emotion, but I route it into something productive – clarifying questions, structured summaries. I guess that's why your data showed my Calmness staying relatively high in tough conversations.

Participant C linked this regulation directly to professional maturity:

> After managing enough high-stakes decisions, my emotional reactivity reduced. I still feel tension, but it doesn't spike.

These accounts are consistent with the relatively flat Calmness and heart rate curves across difficulty levels; the absence of large physiological spikes in "difficult" meetings does not imply a lack of challenge but rather reflects skilful modulation of posture, breath, attention and interpretation. The interviews also show that participants are aware, to varying degrees, of their bodily responses. Participant B noted that the feedback from the study revealed "how reactive my body was to switching tools at home. I thought it was just mental fatigue, but seeing the heart rate and Calmness patterns made me understand it's embodied".

These interview-based insights are reflected in the 2026 questionnaire, in which approximately two-thirds of respondents indicated that they are generally able to maintain outward calm and professional composure even in demanding or high-stakes meetings. Nearly half reported that they consciously use embodied strategies such as posture, breathing or stillness to regulate themselves under pressure, with a further group expressing moderate

agreement. This convergence suggests that the physiological stability observed across meeting intensities reflects a broadly shared repertoire of embodied self-regulation, even if such strategies vary in explicit awareness.

Given that managers highlighted cross-hierarchical and cross-functional relationships (N–1, N + 1, R&D leaders, headquarters management, engineers, PM colleagues) as central to their work and reported mid-to-high levels of perceived control over their own affairs, it is unsurprising that they have developed sophisticated repertoires of emotional and attentional labour. The relative stability of physiological indicators across meeting intensities can thus be interpreted as an outcome of these embodied professional practices. Table 3 provides an overview of the embodied self-regulation strategies described by the project managers, illustrating how posture, breathing, stillness and cognitive reframing correspond to the relatively stable Calmness and heart rate profiles observed across meetings of differing self-reported difficulty.

ICT intensity and cognitive calm in digitally mediated work

The third dimension of analysis concerned ICT complexity, which ranged from low (single-platform communication) to high (parallel use of multiple digital tools). A cross-case comparison revealed a systematic interaction between ICT intensity and work environment, indicating that the cognitive consequences of digital load are strongly context dependent.

In the office environment, EEG Calmness remained relatively consistent across low, medium and high levels of ICT complexity. The structured nature of the office – characterized by shared rhythms, fewer domestic interruptions and stable social cues – appeared to buffer the attentional demands of digitally intensive interactions.

In contrast, at home, participants exhibited a clear decline in EEG Calmness as ICT complexity increased. Meetings requiring multiple tools or frequent switching seemed more cognitively taxing in this setting, where sensory cues and social structures were less regular.

Overall, these findings suggest that ICT complexity does not operate independently; its effects on embodied cognition are shaped by the affordances of the surrounding environment. High ICT load becomes more challenging in less structured contexts, highlighting the interaction between technological demands and spatial conditions.

Data from both questionnaires provide convergent support for this pattern. In the 2026 questionnaire, a substantial majority of project managers agreed that using multiple digital tools in parallel is more mentally exhausting at home than in the office, and that frequent switching between platforms makes it harder to sustain focus during meetings. Perceptions that the office environment more strongly supports attention were more mixed, although a notable proportion indicated that shared rhythms and spatial boundaries help stabilize focus during digitally intensive work.

Participants described this interaction in strikingly similar terms. For Participant A, the primary driver of afternoon decline was “mainly tool switching”:

> When I’m juggling Teams, Miro, WhatsApp, Jira – especially at home – it feels like each platform pulls a thread of my attention. In the office, the same digital workload feels smoother. The environment has fewer unpredictable variables, and I’m less tempted to micro-multitask.

Participant B emphasized how home and ICT interact:

> Home is full of micro-stimuli – notifications, family sounds, even positive distractions. When a meeting uses three or four tools at once, my attention gets stretched thin. I feel like I’m working in panoramic mode – wide but shallow.

Table 3. Embodied self-regulation strategies during project meetings

Participant and excerpt	Type of strategy	Link to physiological pattern	Interpretation
Participant A: "I rely on small, embodied cues – straightening my posture, grounding both feet, inhaling before responding. Over the years those became automatic. It's not deliberate anymore; it's part of how I maintain a steady leadership presence. People expect composure from me, and my body has learned to support that"	Postural grounding; breath regulation; automatic bodily routines	Calmness, heart rate and movement calm state vary only modestly across meetings rated as more or less difficult	Professional identity as "steady leader" is enacted through embodied micro-practices that dampen visible arousal
Participant B: "I manage by mentally separating the layers of the interaction. Sometimes I need to project calm even when I'm uncertain. I don't suppress the emotion, but I route it into something productive – clarifying questions, structured summaries. I guess that's why your data showed my calmness staying relatively high in tough conversations"	Cognitive reframing; emotional routing into task structure; performance of calm	EEG calmness remains relatively high even in subjectively demanding meetings	Emotional labour and attentional control transform internal uncertainty into outwardly composed, structured behaviour
Participant C: "I go still. I lower my movement, adjust my breathing, and focus my eyes on a single point. I didn't know you were tracking movement calmness, but that's exactly what I do to regain cognitive grip"	Movement stillness; breath focus; visual anchoring	Relatively high movement calm state in demanding meetings; absence of large motion artefacts in EEG during tense moments	Managers actively use the body as a tool to stabilise attention and preserve cognitive control under pressure

Participant C recalled "one afternoon at home" with a multi-tool workshop – "slides, Miro, Teams chat, two browser tabs" – that "was too much", producing a sense that attention "collapse[d] like a wave", whereas "later that week in the office, we held the same workshop, and it felt dramatically more stable".

These accounts also highlight how spatial context shapes the experience of ICT load. Participant B contrasted the "micro-stimuli" at home with the office's "natural rhythm" where "people move around, conversations flow, but it actually stabilizes me. It nudges me into a work cadence. Even the spatial cues – meeting rooms, whiteboards – help anchor my attention". Participant A similarly stated that "at home, I need to create my own structure – closed door, strict calendar blocks, a physical boundary for the workday. In the office, structure is embedded in the environment. That makes the cognitive experience of the day very different".

Participant C framed hybrid work more broadly as a trade-off:

> Hybrid work gives me freedom, which I value. But the constant context switching – digital, spatial, emotional – adds a layer of fragmentation I didn't anticipate. The wearable data actually validated that sensation. My body reacts first, long before I consciously feel overloaded.

Data from questionnaires corroborate that managers' everyday work is structurally saturated with ICT and interaction: respondents reported that their daily routines centre on meetings, reading and answering emails, online communication and work with electronic applications, while non-routine activities include customer meetings, escalation management, project committees and systems deployment. Formal scheduled meetings and documented electronic communication emerged as the most frequently used media.

Against this backdrop, the EEG patterns and interview excerpts jointly suggest that high ICT complexity is sustainable when embedded in the office's stabilizing rhythms and spatial cues, but more easily tips into cognitive overload in home settings rich in competing stimuli and requiring self-imposed structure. Table 4 integrates these findings by juxtaposing interview evidence, questionnaire patterns and EEG Calmness trends for different levels of ICT complexity in home and office settings, highlighting how the same digital workload can be experienced as either buffered or fragmenting depending on spatial affordances.

Discussion

The findings demonstrate that temporal rhythms play a central role in shaping embodied attention in hybrid project work. Across the three cases, clear diurnal patterns emerged: EEG Calmness and attentional stability tended to be higher in the morning and declined as the afternoon progressed. These fluctuations resonate with well-established circadian mechanisms that influence alertness, mood and decision-making (Golder and Macy, 2011; Monk and Folkard, 2020). Our findings suggest that these temporal variations are not purely biological; they intersect with organizational scheduling, meeting rhythms and task expectations. The interaction between circadian tendencies and institutional time structures demonstrates how attentional stability is jointly shaped by biological, embodied and organizational rhythms.

Beyond temporal dynamics, the findings reveal that project managers actively regulate attention through embodied micro-practices embedded in everyday work. Across all contexts, participants engaged in subtle micro-practices – brief pauses, posture shifts, focused breathing – to regulate cognitive strain. These momentary adjustments exemplify the form of situated agency described in embodied organizational scholarship (Styhre, 2004; Faraj, Jarvenpaa, and Majchrzak, 2015). Importantly, participants did not frame these practices as deliberate coping strategies, but as routinized, almost automatic responses

Table 4. ICT complexity, spatial context and attentional experience

Case evidence (interviews and questionnaire)	Context (environment and ICT)	Observed / reported effect on attention and calmness	Interpretation for hybrid project work
Participant A: "mainly tool switching. When I'm juggling teams, miro, WhatsApp, jira – especially at home – it feels like each platform pulls a thread of my attention"	Home; high ICT complexity (multiple tools, frequent switching)	Subjective sense of attention being split across platforms; EEG calmness decreases in high-complexity home sessions	Digital fragmentation is amplified in home settings, where fewer shared cues and more micro-stimuli make multi-tool work more fragile
Participant A: "In the office, the same digital workload feels smoother. The environment has fewer unpredictable variables, and I'm less tempted to micro-multitask"	Office; comparable ICT complexity	Calmness remains relatively stable across low, medium and high ICT complexity in the office	Office rhythms and spatial cues buffer the cognitive load of dense digital work
Participant B: "home is full of micro-stimuli – notifications, family sounds, even positive distractions. When a meeting uses Three or Four tools at once, my attention gets stretched thin. I feel like I'm working in panoramic mode – wide but shallow"	Home; high tool use; multiple parallel stimuli	Subjectively "wide but shallow" focus; tendency towards fragmentation in high-complexity online meetings	Home environments require stronger self-imposed structure to prevent attentional dispersion when ICT intensity rises
Participant B: "the office has a natural rhythm – people move around, conversations flow, but it actually stabilizes me. It nudges me into a work cadence. Even the spatial cues – meeting rooms, whiteboards – help anchor my attention"	Office; moderate to high ICT load within structured setting	Attention experienced as anchored by spatial and social cues; calmness more stable in office sessions	Hybrid design should acknowledge the office as a cognitive scaffold, not just a physical location
Participant C: "One afternoon at home I had a multi-tool workshop – slides, miro, teams chat, Two browser tabs. It was too much. I felt my attention collapse like a wave. Later that week in the office, we held the same workshop, and it felt dramatically more stable"	Same task in Two contexts: home vs office; high ICT complexity	At home: perceived attentional collapse, lower calmness; in office: more stable experience and physiological profile	The cognitive impact of ICT complexity is highly context-dependent; spatial affordances modulate overload
Participant C: "hybrid work gives me freedom, which I value. But the constant context switching – digital, spatial, emotional – adds a layer of fragmentation I didn't anticipate. The wearable data actually validated that sensation. My body reacts first, long before I consciously feel overloaded"	Hybrid overall; home/office switching; ongoing digital transitions	Experienced fragmentation; early bodily signals of overload precede conscious awareness	Hybrid work combines valued autonomy with a risk of subtle, embodied overload; physiological sensing can surface these early warning signs

developed through professional experience, indicating that attentional regulation is enacted continuously at the bodily level.

This pattern highlights the role of professional identity in shaping embodied cognition in project management. Experienced project managers appear to internalize expectations of composure, stability and leadership presence, enacting these expectations through bodily regulation. Cognitive composure thus emerges not simply as an individual capability, but as an embodied dimension of what it means to "be" a project manager. This extends embodied cognition theory by showing how professional roles sediment into bodily routines that support sustained attention under conditions of uncertainty, time pressure and relational complexity.

Further insight concerns the relative stability of physiological responses across meetings of differing self-reported difficulty. Rather than indicating an absence of challenge, this stability suggests that experienced project managers draw on well-developed emotional regulation and attentional control – forms of emotional and attentional labour that are critical yet often overlooked in project coordination (Zapf *et al.*, 2021; Müller and Turner, 2010). The findings extend this perspective by showing that such labour is also physiological and embodied, involving posture, breath, stillness and attentional framing. Attentional stability thus appears as a dimension of professional expertise embedded in routines of sensemaking and affective management (Clarke, 2010; O'Connor, Wiewiora, and Spark, 2024; PMI – Project Management Institute, 2021). Although project outcomes were not measured directly, the observed stability in composure aligns with prior evidence linking attentional control and emotional regulation to project success (Turner and Müller, 2005).

The analysis further shows that ICT complexity influences embodied cognition in a strongly context-dependent manner. Higher levels of digital saturation were associated with reduced EEG Calmness in home settings, whereas calmness remained comparatively stable in the office. This pattern highlights the role of spatial affordances in shaping how cognitive demands are experienced and regulated. Drawing on theories of extended and distributed cognition (Clarke, 2010), the office can be understood as a cognitive scaffold that stabilizes attention through material cues, shared rhythms and embodied routines.

By contrast, home environments require individuals to actively construct their own regulatory structures. In digitally intensive meetings, the absence of shared spatial cues amplifies attentional fragmentation, particularly when multiple tools are used in parallel. Visual artefacts such as whiteboards, shared screens and spatial anchoring points function not merely as communication devices but as cognitive supports that offload attentional demands. These findings extend cognitive load theory (Sweller, 1988) by demonstrating that ICT-induced strain is not inherent to technology itself but emerges from its interaction with spatial and material conditions.

Finally, the study demonstrates how neurophysiological indicators, when combined with qualitative interpretation, can surface subtle cognitive and affective processes that are difficult to capture through self-report alone. EEG Calmness, heart rate and movement stillness functioned as complementary traces of embodied experience rather than objective measures of performance. While such tools raise important interpretive and ethical considerations, the findings align with calls to use physiological data not as deterministic predictors but as situated resources that enrich qualitative organizational inquiry (Parasuraman and Wilson, 2008; Winter *et al.*, 2006). Rather than treating physiological signals as determinants, this study positions them as interpretive resources that help theorize the embodied, affective and material dimensions of hybrid project work. This approach contributes to emerging efforts to integrate mobile neuroergonomics into organizational research in a theoretically grounded and ethically reflexive manner (Wascher *et al.*, 2021).

Study limitations and future research

This study uses an idiographic multiple-case design with three project managers in a single firm. While limiting statistical generalizability, small-N case studies are well suited to theory building in complex, context-dependent domains such as project work (Flyvbjerg, 2006). The cases therefore offer analytic insight and theoretical propositions rather than population-level claims.

While we added two organizational questionnaires to provide comparative context, these data do not constitute a second qualitative method such as focus groups or shadowing, nor were they used for statistical inference. Their role was to situate the idiographic patterns within broader managerial rhythms in comparable hybrid contexts. Future research could use fuller methodological triangulation (e.g. ethnography, diaries or team-level observation) to deepen process explanations and assess transferability.

Although physiological measures offer valuable insight into moment-to-moment cognitive states, they cannot fully capture the sociocultural depth of organizational experience. Integrating neuroergonomic data with richer qualitative methods – such as interviews, ethnographic observation or shadowing – would further enrich interpretation and illuminate how embodied processes intersect with professional identity, power relations and emotional labour.

Data collection spanned multiple months but consisted of discrete measurement episodes rather than continuous tracking across entire project life cycles. Subsequent studies could follow embodied cognitive rhythms longitudinally across project phases, linking attentional dynamics to project evolution and outcomes.

The analytical focus on individual project managers provides insight into personal embodied regulation but offers limited visibility into collective cognitive processes. Future research could adopt team-level designs, including multi-person physiological monitoring or synchrony analysis, to examine shared attention, emotional contagion and collective regulation in hybrid project teams, consistent with systemic perspectives in PM-2.

Finally, as physiological monitoring becomes more accessible in organizational settings, ethical issues surrounding privacy, consent and psychological safety become increasingly salient. Future research should further explore participatory governance frameworks that protect individual autonomy while enabling responsible and constructive use of biometric data.

Conclusions

As the boundaries between work, life and the body continue to blur, understanding how individuals regulate their internal states become essential for capturing the lived realities of contemporary project work – particularly in project management, where temporal pressure, boundary spanning and high emotional labour coincide with limited formal authority. This study demonstrates that cognition is not an abstract, disembodied process but an ongoing, embodied negotiation shaped by institutional expectations, technological mediation and temporal rhythms. Across the three qualitative cases, the findings reveal how attentional stability fluctuates with daily cycles, how digital complexity interacts with spatial context, and how experienced project managers rely on embodied self-regulation to maintain composure during hybrid collaboration.

These insights point towards a more situated conception of cognitive composure – one grounded in the interaction between biological rhythms and the socio-material conditions in which work unfolds. They suggest that the design, frequency and contextual affordances of ICT systems structure not only communication and coordination but also the biophysical

economy of attention. In hybrid settings, digital saturation can produce subtle but meaningful cognitive strain that often remains invisible yet is traceable through physiological signals.

By bringing the body's rhythms and responses to the forefront, the study contributes to an emerging organizational perspective that views cognition as distributed, situated and enacted. Rather than offering prescriptive recommendations, the findings encourage scholars to examine how temporal patterns, digital infrastructures and spatial arrangements shape the everyday experience of project managers. This perspective supports a more human-centred organizational analysis – one that recognizes the embodied, affective and rhythmic dimensions of sustaining professional practice in technologically saturated environments.

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