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Innovators and transformers – filling the void: informing operations management research and practice by applied neuroscience

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Abstract

Purpose – Historically, operations management research and practice have largely overlooked the variability among individual workers, often treating them as interchangeable components. This paper explores the potential benefits of incorporating neurobiological response monitoring to advance human-centric approaches in these domains.

Design/methodology/approach – Drawing on existing evidence of using neurobiological responses to study human factors, this study identified three conceptual areas of added value for operations management research: identifying mechanisms underlying workers' performance, objectively complementing self-reports through implicit responses measurement, and enabling continuous, real-time data collection. A proof-of-concept experiment in a laboratory setting, which replicated a factory assembly line, demonstrated the added value of neurobiological response monitoring in operational contexts (annex).

Findings – Building on the three conceptual areas of added value, we propose a set of research questions aimed at advancing understanding in operational domains shaped by human variability. Adopting a human-centric perspective, we focus on four dimensions: productivity, flexibility, safety and well-being.

Practical implications – Integrating neurobiological response monitoring into operations management provides a novel lens for human-centric management, enabling workforce variability to become a competitive advantage. Managers must address privacy and acceptance concerns by framing neurobiological response monitoring as mutually beneficial, while building skills and governance structures to translate neurobiological data into actionable decisions.

Originality/value – By introducing neurobiological response monitoring to operations management, this paper addresses overlooked human variability and answers calls for methodological innovation. It contributes by outlining conceptual added value and practical implications for researchers and managers.

Keywords Human-centricity, Neuroscience, Biometrics, Industry 5.0, Methodology

Paper type Research article

1. Introduction

Historically, both managers and researchers have recognised that operations management is rooted in the role, interaction and impact of human workers, often describing it as a "people

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business" (Schorsch *et al.*, 2017). This is especially true in operations, where value creation heavily depends on predominantly blue-collar workers (Ashraf *et al.*, 2024). Despite this reliance, much of the research and many operational models continue to treat operators as interchangeable components, overlooking the variability between individuals (Moghaddam and Klumpp, 2025). A clear example is the vehicle routing problem, where planning models typically ignore human factors such as drivers' fitness, attention levels, or even chronotypes (Keil and Klumpp, 2025). In such models, one driver is treated the same as any other, an assumption that oversimplifies the complexity of operational environments.

Recently, however, researchers have begun to recognise the uniqueness of human operators and are shifting toward designing systems tailored to them. This shift is aligned with the transition from Industry 4.0 to Industry 5.0, which emphasises human-centric approaches (European Commission, 2021; Lou *et al.*, 2025). In response, scholars have increasingly called for the integration of human factors into both research and operational practice (Azani *et al.*, 2025; Brunner *et al.*, 2024; De Lombaert *et al.*, 2023). At its core, human factors research has the aim to understand how operators perceive and behave within context-dependent environments, making it highly important for the development of human-centric systems. Human factors have been conceptualised to encompass individual states like fatigue, attention, stress and emotion, each influencing distinct biological responses across cortical, cardiovascular, muscular and hormonal systems (Loizaga *et al.*, 2023).

While this shift has prompted some studies to consider physical responses such as metabolic cost or exertion (Ashta *et al.*, 2025), far fewer have explored neurobiological responses, typically limited to laboratory settings and focused on single measures like brain activity (Morton *et al.*, 2022; Ren *et al.*, 2023). This gap is significant, as neurobiological responses often reflect internal states that precede or accompany observable behaviour (Andreassi, 2010). Despite their relevance to a human-centred understanding of operational performance (Loizaga *et al.*, 2023), these responses remain largely overlooked in operations management research, with limited conceptual exploration of their potential value. In contrast, adjacent fields such as marketing and economics have demonstrated the added value of analysing these human responses, particularly for informing management decisions (Randall *et al.*, 2014). Bridging this conceptual gap requires a clearer articulation of the domains where considering neurobiological human responses can enhance research and practice.

Based on this outlook, this paper explores the potential benefits of integrating neurobiological response monitoring into operations management research and practice. First, drawing on existing empirical evidence, we identify three key conceptual areas where tracking workers' neurobiological responses can enhance research in this domain. Second, we formulate a set of research questions to guide future research. Third, we consider the practical implications for managers and organizations. Overall, this paper contributes to the growing literature by responding to recent calls for methodological innovation (Russo and Rao, 2025; Russo *et al.*, 2024) and equip researchers and managers for the emerging area of human-centric operations management.

2. The added value of monitoring neurobiological responses

The practice of monitoring neurobiological responses in individuals during tasks or decision-making is well-established within the social sciences. The integration of neuroscientific methods has become increasingly prevalent in interdisciplinary research, with a growing emphasis on real-world applications (Levallois *et al.*, 2012). Fields such as consumer neuroscience, neuroethics, neuro-information systems, neuroeconomics and organisational neuroscience have been particularly receptive to integrating neuroscience and biological theories and methods to study human behaviour, cognition and decision-making (Plassmann *et al.*, 2015; Dimoka *et al.*, 2011; Farah, 2005; Glimcher and Rustichini, 2004; Becker *et al.*, 2011). The adoption of biological measures stems from the established mind-body connection, which highlights a bidirectional relationship between physiological and psychological processes. This suggests that analysing one can provide insights into the other and vice versa (Green *et al.*, 1970). This approach differs from traditional behavioural methods, which largely originate from cognitive and social psychology and infer performance drivers from observable actions such as choices, errors or completion times (Bendoly *et al.*, 2010). In contrast, neurobiological approaches directly measure the underlying bodily responses that precede or accompany these behaviours.

These measures are assessed using various tools that monitor cardiac, dermal, cortical, sub-cortical, hormonal, ocular and other biological responses. Each tool differs in temporal and spatial resolution, catering to different research questions. Consequently, while some tools are adaptable to field studies, others are confined to laboratory settings. Comprehensive reviews in parallel disciplines like marketing (Lim, 2018), consumer psychology (Clithero *et al.*, 2024) and organisational behaviour (Senior *et al.*, 2011) further discuss these differences, which are considered beyond the scope of this paper.

In the context of operations management research, we propose that incorporating neurobiological response monitoring offers at least three distinct conceptual contributions. First, neurobiological data helps identify mechanisms underlying workers' performance, helping to explain and contextualise how specific individual human factors can drive and shape operational outcomes. Second, such monitoring enables the parallel measurement of visceral responses, providing an objective perspective on workers' experiences that complements subjective self-reports. Visceral reactions are unconscious, automatic physiological reactions to external stimuli that are controlled by the autonomic nervous system. Third, incorporating neurobiological response monitoring enables real-time and continuous data collection dedicated to individual workers, incorporating a temporal dimension into the analysis of human factors. These three areas of conceptual value are further tested by an exploratory proof-of-concept experiment conducted in a controlled environment resembling an industrial facility, where participants performed an assembly task. The experimental methods, procedure and results are detailed in the Online Appendix. In the following, we discuss each of these areas.

2.1 Identification of mechanisms underlying workers' performance

Traditionally, research has often approached the human element as a "black box", focusing primarily on how changes in the work environment influence observable performance outcomes, while largely overlooking the internal processes that shape individual performance.

For instance, Miltenburg (2001) examined how structural and procedural characteristics (e.g. operator multi-skilling and standardised workflows) impact productivity, lead time and quality. This approach largely relies on a stimulus-response model, assuming uniformity in worker behaviour after receiving standardised training and workflows.

By contrast, a neuroscience-informed perspective centres on the individual, examining the human factors that mediate the link between environmental conditions and performance outcomes (Plassmann *et al.*, 2015). Building on this perspective, we propose that neurobiological responses can serve as mediators that explain the relationship between manipulated variables (e.g. workplace setting conditions) and observable performance metrics (e.g. pickup time or speed) in operational contexts. This approach is consistent with research in related fields such as communication and marketing that demonstrate that business outcomes can be better understood by exploring how individuals process stimuli and how this processing leads to specific outcomes (Mandolfo *et al.*, 2025). Along these lines, our proof-of-concept experiment investigated whether neurobiological responses, specifically cardiac and cortical activity, triggered by task complexity during an assembly activity could mediate the relationship between environmental conditions and operational performance. The results confirmed that both these neurobiological responses serve as mediators, explaining the mechanism by which task complexity impacts internal states, which in turn influence performance. High task complexity increased cortical activity, which in turn increased fluency and thus reduced error rate. These findings validate a mediation process where task sequence complexity affects physiological responses, which then influence self-reported and ultimately operational performance (for more details on the experiment see Online Appendix).

Monitoring neurobiological responses thus offers an approach for explaining variability in how individuals respond to operational demands. This challenges the assumption of behavioural uniformity and questions the belief that standardised workflows necessarily lead to standardised results. Conceptually, this represents an important shift: it moves the unit of analysis from average effects to the intra- and inter-individual mechanisms that underlie performance. This perspective aligns with Moghaddam and Klumpp's (2025) call to measure workers' physiological states, advocating for systems that accommodate individual variability rather than enforcing uniformity.

2.2 Measurement of implicit processes

Many foundational theories in operations management assume that workers behave as rational actors who make predictable decisions when provided with standardised workflows and proper training (Fahimnia *et al.*, 2019). This view equates rationality with goal-oriented behaviour in which individuals choose actions that maximise efficiency and can articulate their rationalisations. However, recent neuroscience research offers a contrasting view, suggesting that much of the information processing influencing workplace attitudes, emotions and behaviour occurs subconsciously (Waldman *et al.*, 2019). These subconscious or implicit processes are not easily accessed through verbal self-reports, especially when they involve fast, visceral responses such as arousal, stress or attentional shifts. In this paper, we differentiate between implicit processes, which are automatic and beyond conscious control, and explicit processes, which involve conscious deliberation and rely on explicit self-reporting (Becker *et al.*, 2011).

Building on this perspective, we propose that neurobiological responses offer a means of measuring implicit aspects of human factors that may be difficult for the operator to articulate but are central to understanding performance. This approach finds parallels in consumer psychology, where similar methods are used to evaluate consumer reactions that are not easily articulated (Shaw and Bagozzi, 2018). Similar approaches have also been validated in controlled environments, such as simulated assembly tasks. Cortical activity patterns have been used to measure neurophysiological correlates of cognitive workload (Morton *et al.*, 2022; Ren *et al.*, 2023). These early findings reinforce the well-established link between mind and body (Green *et al.*, 1970). From a human-centric perspective, this provides a useful lens for examining how both implicit and explicit responses related to human factors influence performance outcomes. In line with this, our proof-of-concept experiment examined the relationship between physiological arousal and self-reported arousal as predictors of operational performance. Our findings showed that implicit measures provided a significantly stronger prediction of performance than explicit self-reports. This indicates that physiological data may offer added value in understanding behaviours in operational settings (see Online Appendix).

Conceptually, the ability to measure implicit processes through neurobiological responses represents an advance in the study of human factors in operations management research. This approach allows researchers and practitioners to complement what operators report (i.e. subjective perceptions) with how their bodies respond (i.e. objective responses). This dual perspective can help identify fundamental human factor responses (e.g. arousal, stress, attention) that often occur outside conscious awareness but nonetheless significantly influence performance (Loizaga *et al.*, 2023). Moreover, connecting these responses to measurable neurobiological signals strengthens the scientific foundations of human-centric operations research by linking subjective reports with physiologically grounded evidence.

2.3 Real-time and continuous data collection

Traditional operations management research on human factors has long faced challenges due to the limited accessibility of these individual processes (Flynn *et al.*, 1990). Researchers have typically relied on theoretical constructs and captured these human states only indirectly through self-reports, gathered either before a task to assess expectations or afterward to capture retrospective interpretations. However, these measurements were seldom taken during the activity itself, which means researchers must depend on participants' recollections of the experience. The introduction of wearable measurement tools addresses this limitation by enabling continuous, real-time monitoring of neurobiological processes. Also, the passive nature of these measurements (e.g. cardiac, dermal, or ocular responses can be recorded through non-invasive biosensors) does neither require active participation from individuals nor interrupt the task to obtain feedback. Furthermore, these measurements are now increasingly assessed in real-time, facilitating the analysis (Hu *et al.*, 2024).

Building on this premise, we propose that neurobiological responses can be measured throughout the entirety of operational tasks. This enables researchers and practitioners to include a temporal dimension into the analysis of human factors, assessing not only what is experienced, but when and for how long. This approach aligns with methodologies used in fields like behavioural economics, where neuroscientific tools are similarly employed to monitor individual processes over time (Studer *et al.*, 2016). In line with this perspective, our proof-of-concept experiment evaluated the feasibility of real-time, continuous data collection by recording both cardiac and cortical activity throughout the task. We focused on signal quality to assess the practical suitability of wearable biosensors, and our findings confirm that these wearable sensors can adequately assess continuous cardiac and cortical responses in typical operational settings (see Online Appendix).

3. Propositions for advancing research

Building on the three conceptual areas of added value of neurobiological response monitoring, we propose a set of research questions to advance understanding in operational domains shaped by human variability. Adopting a human-centric perspective, we focus on four dimensions: productivity, flexibility, safety and well-being. These dimensions were selected for their relevance to both individual experience and organisational performance. The research areas and questions are summarised in Table 1 at the end of this section.

Productivity remains a cornerstone of operations management, historically rooted in Taylorist principles that emphasise pace and output. Yet conventional productivity models often ignore the variability in how individuals experience and sustain productivity over time (Corbett, 2024). This raises questions about how productivity should be measured in human-centric operational systems. A first area for future research concerns the neurobiological mechanisms underlying individual responses to work pace. While some individuals may perform well under time pressure, others may experience stress or fatigue. Research could explore how changes in cortical activity or cardiac responses mediate the relationship between pace and productivity. For example, building on existing research (Keil and Klumpp, 2025), studies may examine how factors like chronotype or baseline stress interact with task characteristics to influence work-related flow or productivity. Second, we see an opportunity to rethink how productivity is defined and measured in operations management research. Future research could investigate the integration of neurobiological data into new forms of productivity assessment. For example, by expanding the concept of metabolic cost (Ashta *et al.*, 2025) to include rest allowance and recovery needs. The concept of metabolic cost refers to the physiological energy required to perform a task. Including rest allowance and recovery needs into the concept would support a broader view of productivity, aligning operational goals with human factors. A third research opportunity lies in the temporal dynamics of productivity. Since workers' cognitive capacity or stress levels may fluctuate throughout the day (Fisher *et al.*, 2017), real-time physiological monitoring offers an opportunity to map these dynamics. Future studies may track, for instance, variations in cardiac responses during prolonged tasks, exploring how interventions such as breaks, job rotation, or pacing adjustments affect long-term performance.

Table 1. Research questions on human-centric operations

Research area	Research questions
Productivity: Explore how neurobiological response monitoring can reveal hidden physiological costs, individual differences in response to workload, and the temporal dynamics of performance	How do neurobiological responses explain individual differences in productivity under high-paced operational conditions? How can physiological cost indicators be incorporated into productivity metrics to reflect both performance and well-being? How is productivity affected by changes in physiological responses over the course of a high-paced work shift?
Flexibility: Investigate how neurobiological responses to uncertainty shape cognitive load, emotional anticipation, and performance in operational environments that demand adaptation and decision-making under ambiguity	How do neurobiological responses mediate the relationship between task predictability and performance, particularly in environments requiring frequent adaptation to last-minute changes? How do anticipated emotions related to upcoming uncertain tasks manifest in pre-task neurobiological responses and how do these responses affect subsequent cognitive load and decision quality? Does managing or overriding uncertain AI-generated recommendations lead to elevated physiological stress, and how can this be measured in real time?
Safety: Examine how neurobiological response monitoring can detect early signs of cognitive strain, uncover physiological markers of resilience, and assess the long-term costs of vigilance in safety-critical environments	How can neurobiological responses serve as early-warning indicators of fatigue before errors or accidents occur in operational environments? What specific neurobiological profiles differentiate resilient workers from those more susceptible to performance decline? How does long-term exposure to highly regulated safety environments impact workers' stress regulation, hormonal balance, and resilience?
Well-being: Examine how neurobiological data can reveal hard-to-access responses and long-term physiological effects of operational environments on workers' health	To what extent do discrepancies between subjective self-reported and objective physiological stress indicate hidden strain? How do neurobiological signals mediate the internalisation of psychological strain caused by low-autonomy or ethically ambiguous work environments? What is the long-term physiological impact of sustained exposure to psychologically taxing conditions?

Source(s): Authors' own elaboration

The second research area we focus on, addresses the balance between deterministic control and probabilistic flexibility, an equilibrium that affects how workers experience cognitive load (Corbett, 2024). Building on this perspective, a first opportunity lies in identifying the neurobiological mechanisms through which workers respond to uncertainty. Tasks requiring adaptation (e.g. managing last-minute changes) may trigger different patterns of cortical activity or cardiac variability than predictable tasks. Future research could explore how these physiological responses mediate performance, helping to identify whether specific forms of uncertainty place a heavier load on cognitive processing. Second, in working environments anticipatory stress may arise when workers expect disruption, even before it occurs. This is linked to anticipated emotions, such as expected frustration or anxiety, depending on how workers mentally simulate future events. These emotions, although not yet triggered by actual outcomes, can shape present physiological states and influence decision-making (Neubauer *et al.*, 2018). Future research could use pre-task neurobiological responses to assess how uncertainty about upcoming tasks generates cognitive load. Such work would help clarify how planning horizons influence worker performance through the lens of anticipated affect. Third, the growing integration of AI forecasting and decision-support systems introduces new cognitive demands. As workers increasingly operate as overseers or override agents, they must interpret probabilistic outputs. This can cause cognitive strain, especially when AI outputs are uncertain or conflicting (Fügener *et al.*, 2022). Future studies could examine whether neurophysiological responses indicate elevated cognitive load during such interactions. This research would help identify the thresholds at which cognitive load becomes detrimental in human-AI collaboration.

Safety represents the third focus area of our investigation. As Corbett (2024) suggests, there is significant potential in shifting from reactive models to proactive operational designs that anticipate and mitigate breakdowns, particularly those arising from human limitations. In this context, a first opportunity lies in identifying early neurobiological indicators of individual strain that precede incidents. Signals such as declining heart rate variability or increased frontal cortical activation may serve as leading indicators of cognitive overload or fatigue, which are known precursors to unsafe conditions. Building on emerging evidence (Argyle *et al.*, 2021; Hijry *et al.*, 2024), future research could investigate whether these markers reliably predict risky behaviours and how they perform in comparison with conventional safety monitoring tools. Such studies could lay the groundwork for integrating neurobiological data into anticipatory safety systems. Also, the long-term physiological effects of working in highly regulated safety environments remain underexplored. Continuous demands for vigilance may lead to elevated baseline stress, disrupted recovery cycles, or chronic sympathetic arousal. Longitudinal neurobiological response monitoring offers an avenue to examine how sustained exposure to such conditions affects cardiovascular or hormonal responses and how these dynamics interact with compliance requirements, informing strategies for workforce resilience.

Well-being represents our fourth focus area of investigation, broadening the scope of operations management to encompass the psychological, emotional and cognitive health of workers (Corbett, 2024). Along these lines, a first research opportunity lies in identifying the implicit processes that shape behavioural responses in operational settings. In some work settings, workers may avoid reporting discomfort due to social norms or fear of burdening colleagues (Sanne, 2008). In such contexts, physiological indicators like skin conductance, heart rate variability, or ocular responses (e.g. measuring pupil dilation, blink rate, eye movements) can be indicative of stress responses that remain unspoken (Hijry *et al.*, 2024). Future research could compare subjective workload reports with objective physiological data to identify mismatches between perceived and actual strain, offering a more accurate picture of worker well-being. Second, well-being is shaped not only by workload but by how operational systems influence workers' emotional experience. Repeated exposure to low-autonomy environments or ethically ambiguous directives may result in chronic physiological stress, which is reflected in cardiac responses (da Estrela *et al.*, 2021). Considering this issue, future research could examine how neurobiological responses mediate the internalisation of psychological strain, helping to identify operational conditions that affect well-being over time. This contributes to the identification of mechanisms through which human costs emerge in everyday operations. Finally, longitudinal monitoring offers insight into the cumulative impact of demanding environments. Sustained exposure may lead to diminished affective responsiveness or heightened baseline stress. Future studies could assess whether adaptive work design or biofeedback tools help restore physiological balance.

Beyond these research questions, several methodological considerations must guide future investigations. First, operations tasks involve a mix of human functions including attention, memory, decision-making and motor control. For example, in an order picking scenario, workers must recall item locations, select efficient routes and execute physical movements to retrieve items. Isolating the specific neurobiological responses involved in these tasks requires caution from researchers. To address this complexity, we propose that future in-field experiments focus on manipulating individual cognitive functions to observe their neurobiological correlates and impacts on performance, while ensuring ecological validity. Advances in wearable technology and sensor miniaturisation now make it feasible to collect multimodal data directly in operational environments (Loizaga *et al.*, 2023). This approach aligns with methodologies employed in other experimental contexts, where isolating specific cognitive functions allows to better understand their individual contributions and interactions (vom Brocke and Liang, 2014).

Second, the practical application of neurobiological metrics to real-world performance in operations management remains challenging, with a notable gap between physiological data and work performance outcomes. Although neuroscientific tools can be proven capable of monitoring correlates of cognitive load, stress and attention, there are currently no well-defined benchmarks to gauge what constitutes "optimal" biological activity specific to operations environments. Consequently, there is a need for future research to establish industry-specific baselines tailored to various operations roles. For instance, roles that primarily involve sitting, such as monitoring systems or controlling automated processes, may show distinct cardiac patterns compared to roles that involve standing or more physically intensive tasks like order picking or forklift operation. To address these challenges, it will be needed to explore the relationship between various physiological data (e.g. cortical, hormonal, ocular, or cardiac data) and established productivity metrics (e.g. pickup speed or order accuracy) to identify any correlational or causal effects. Initially, comparing these findings with established self-reported worker feedback and evaluations will help bridge the gap between objective physiological measures and subjective psychological assessments. In later research phases, the focus may shift towards developing AI-driven predictive models that can analyse biological data alongside behavioural factors, thus laying the groundwork for behavioural predictions based on physiological inputs.

Moreover, the fast-paced and physically demanding settings of operations pose challenges for using devices that measure neurobiological responses, as abrupt body movements can significantly affect signal quality. For example, the sudden movements a forklift operator experiences amid vibrations can introduce substantial noise into the data due to sensor movement. Consequently, there is a need for future research to create models, potentially aided by AI due to the size of data involved, that can filter out signal noise from neurobiological data in scenarios characterized by significant body movement. Given the lack of established protocols for data cleaning in these contexts, it is recommended to adopt data cleaning and analysis methods from medical protocols and standards, such as established guidelines for cardiac or cortical data (Malik *et al.*, 1996; Bigdely-Shamlo *et al.*, 2015).

4. Managerial implications

The integration of neurobiological response monitoring into operations offers a novel lens for human-centric management. By understanding three conceptual areas of added value, managers can create measurable impact, transforming workforce variability from a challenge into a source of competitive advantage. In fact, this knowledge of how operators adapt and perform under different operational conditions enables resource allocation tailored to the specific needs of each worker.

Across these areas, the managerial imperative is twofold. First, neurobiological response monitoring must be positioned as a mutually beneficial tool. In fact, privacy concerns and the acceptance of technology for measuring neurobiological responses represent central issues that future management practice must address carefully. Future managers need to recognise that workers may perceive neuroscientific tools as intrusive or means to surveillance, which could lead to resistance in adopting these technologies. To alleviate these concerns, it will be important to articulate the advantages of collecting such data. For example, highlighting that these measurements can improve the understanding of individual worker needs or allow for tailored work schedules based on personal readiness. Involving employees from the beginning (e.g. through consultations or pilot programs) can demystify the technology. Transparent policies should also be established to outline the procedures for collecting, using and storing neurobiological data, ensuring that employees are informed and consenting participants in these initiatives. Second, managers must turn neurobiological data into action through training and specific governance. Training should build multidisciplinary competence, combining operational analytics with knowledge of human factors. This equips supervisors to interpret physiological signals correctly and connect them to operational realities. Cross-training with occupational health, ergonomics and data science teams further strengthens organisational capacity. Governance structures should ensure compliant use of data and employee confidence. Ultimately, it is through these managerial lenses that neurobiological response monitoring can achieve its full impact in shaping human-centric operations. Figure 1 integrates three conceptual areas of added value into four research domains linking them to managerial principles on transparency, competence and training and governance and ethics.

5. Conclusions

Over the past decades, the application of a neuroscientific approach has made significant strides in enhancing the understanding of human behaviour. As the field continues to evolve, there is considerable cause for optimism about the future integration of a neurobiological perspective into operations management research and practice. Building on the research avenues discussed above, future work can advance human-centric operations grounded in neurobiological evidence. At the same time, several considerations must guide practical implementation. Ensuring data quality, ethical governance and organisational readiness remains central for translating neurobiological data into management practice. Moreover, wearable technology and AI-supported data analysis provide the methodological foundation for scaling up to real-world applications that could influence management decisions. Overall, these advancements hold promise for transforming workforce variability into a measurable and manageable advantage in operations management research and practice.

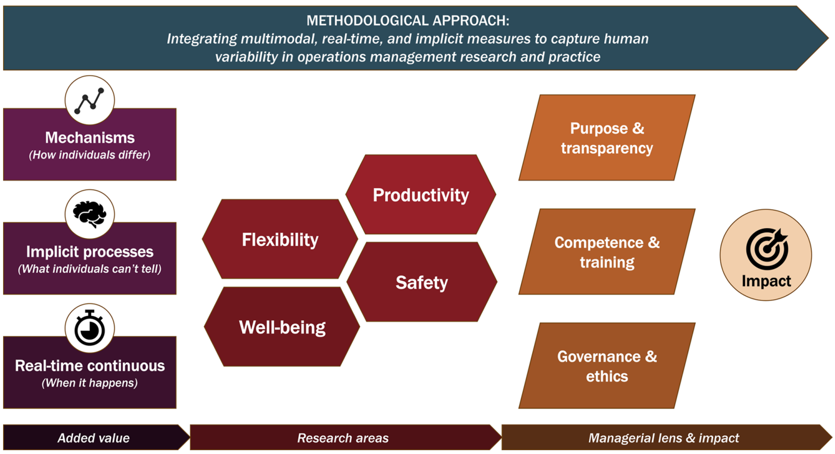

Figure 1. Conceptual framework. Source: Authors' own elaboration

Authorship contribution statement

Matthias Klumpp: Conceptualization, Writing – Review and Editing, Project Administration. Marco Mandolfo: Conceptualization, Methodology, Data Curation, Formal Analysis, Writing – Original Draft. Arnd Meiser: Methodology, Investigation, Data Curation, Writing – Review and Editing. Caroline Grauel: Validation, Writing – Review and Editing.

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Supplementary material

The supplementary material for this article can be found online.

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