GAS Journal of Economics and Business Management (GASJEBM)

Volume 3 | Issue 11, 2026 Homepage: https://gaspublishers.com/gasjebm-home/ ISSN: 3048-782X

From Algorithmic Control to Human–Machine Collaboration: A Review of Research on Technology Responses in Employee Workplaces

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Received: *15.10.2026* | ***Accepted:*** *30.10.2026* | ***Published:*** *01.11.2026*

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DOI: *10.5281/zenodo.23858041*

Abstract **Original Research Article**

Against the widespread deployment of algorithmic systems in workplace organizations, existing studies mostly focus on their technical implementation, transparency mechanisms and social impacts, yet few systematically summarize employees' technology-oriented coping strategies under algorithmic control. This paper reviews relevant literature from six dimensions: terminology framing, algorithmic literacy, system design logic, prediction calibration, and socio-cultural embeddedness. It sorts out the theoretical evolution from algorithmic control toward human-machine collaboration. The review suggests that organizations should move past pure technical optimization, attach importance to individual differences and institutional contexts, and adopt participatory forward-engineering design to realize human-machine co-creation.

Keywords: algorithmic control; human-machine collaboration; algorithmic literacy; forward engineering; socio-technical system; workplace technology.

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1. introduction

As algorithmic systems have become widely integrated across various sectors of society, from the digital transformation practices of companies such as Mpower Financing, Emerson, and ZF (Mpower Financing, 2017; Emerson, 2019a; Vizru Inc., 2019) to Telefonica Deutschland's next-generation cloud solution (Netcracker Technology, 2018), algorithms have become deeply embedded in organizational operations and decision-making processes. They have not only reshaped application scenarios such as virtual analyzers for industrial processes (Bakhtadze, 2004) and predictive policing, but have also sparked profound discussions regarding how algorithmic terminology influences user preferences and trust, how algorithmic literacy shapes public attitudes, and how algorithmic systems are perceived and governed within sociocultural contexts. Existing research has both focused on frameworks for the preservation and transparency of algorithms as technical components—for example, by constructing a three-tier transparency model for the public sector through participatory design (Correa et al., 2026)—and has critically examined how algorithmic design constraints presuppose social consequences, how algorithmic logic interacts with the media to construct stigmatizing representations of immigrant populations (Ieracitano et al., 2024), and the symbiotic relationship between algorithmic infrastructure and human expert knowledge within the organizational culture of platforms such as Wikipedia (Geiger, 2017). However, although

existing literature has examined the technical implementation, social impacts, and transparency mechanisms of algorithmic systems (Hodges & Trace, 2023; Giannopoulou, 2020), few studies have systematically examined how employees can shift from passive adaptation to active human–machine co-creation when confronted with increasingly complex algorithmic control in the workplace. Accordingly, this review aims to integrate relevant literature and provide an in-depth analysis of employees' response strategies within the technological environment of the workplace, thereby clarifying the evolutionary trajectory from algorithmic control to human–machine co-creation and its profound implications for organizations and individuals.

2.Algorithmic Terminology and User Perception: How Language Frameworks Shape Technological Trust

Against the backdrop of the increasing penetration of algorithmic systems into the workplace, understanding how the "terminology" or "labels" presented by technology influence employees 'perceptions, preferences, and trust is key to understanding the psychological mechanisms of human-computer interaction. This sub-theme focuses on the language frame effect: how different modes of description (e.g., "algorithm" versus "chatbot") subtly alter users' perception of a system's objectivity and authority, thereby influencing their willingness to adopt its recommendations. Understanding this mechanism is crucial for designing algorithmic assistive tools that are more user-friendly and more readily accepted by employees. Through two preregistered studies, scholars have conducted in-depth explorations into the impact of terminology on preferences for algorithmic system use. The findings indicate that, regardless of whether a task is subjective or objective, participants are more inclined to accept recommendations provided by systems labeled as "algorithm" than those provided by "chatbots." This result suggests that the label "algorithm" enhances an individual's subconscious perception of a system's objectivity and credibility (Chacon et al., 2026). While no direct counter-studies have yet emerged to refute this terminology effect, some research points out that the inherent complexity of algorithmic systems is often obscured by simplified macro-level terminology; this implies that terminology choice is not merely a matter of expressive preference, but is also related to users' awareness and vigilance regarding the operational details of the system (Giannopoulou, 2020). Collectively, these studies reveal the central role of language in constructing human-computer trust. In summary, the choice of terminology in algorithmic systems is not a neutral technical detail; rather, it serves as a psychological lever that profoundly influences employee behavior and trust. When introducing algorithmic tools, organizations should carefully consider their naming strategies, because specific terminology can significantly enhance employees' adherence to system recommendations, while also potentially obscuring the socio-technical complexity underlying the system. Future workplace designs should leverage this finding by employing precise terminological frameworks to optimize human–machine collaboration experiences, while avoiding the risk of overlooking critical issues caused by excessive simplification.Against the backdrop of the increasing penetration of algorithmic systems into the workplace, understanding how the "terminology" or "labels" presented by technology influence employees 'perceptions, preferences, and trust is key to understanding the psychological mechanisms of human-computer interaction. This sub-theme focuses on the language frame effect: how different modes of description (e.g., "algorithm" versus "chatbot") subtly alter users' perception of a system's objectivity and authority, thereby influencing their willingness to adopt its recommendations. Understanding this mechanism is crucial for designing algorithmic assistive tools that are more user-friendly and more readily accepted by employees. Through two preregistered studies, scholars have conducted in-depth explorations into the impact of terminology on preferences for algorithmic system use. The findings indicate that, regardless of whether a task is subjective or

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3. Algorithm Literacy and Attitude Development: Individual Differences and Intervention Strategies

With the widespread adoption of algorithmic decision-making in the workplace, enhancing employees '"algorithmic literacy" has emerged as a key pathway for alleviating technological anxiety and fostering human–machine collaboration. This sub-theme focuses on how individual factors—such as technological usage experience and information acquisition channels—shape employees' attitudes toward algorithmic systems, as well as what intervention measures can effectively enhance employees 'algorithmic cognitive capabilities. The research aims to explore how to shift from passive acceptance to active understanding, enabling employees to evaluate the role of algorithms in organizational management more rationally. Existing studies have developed intervention frameworks that integrate algorithmic literacy education with personalized user experiences to guide the public toward a rational understanding of algorithms. Relevant experimental results indicate that while intervention measures can improve individuals' attitudes toward algorithms, their effectiveness is constrained by the individual's level of technological proficiency; standardized training targeting the general population often fails to achieve ideal outcomes (Silva et al., 2024). Further research focusing on public-sector scenarios suggests that individuals' demand for algorithmic transparency is not limited to technical explanations of underlying principles; it is also closely linked to institutional trust. When employees or the general public encounter high-impact algorithmic systems, beyond technical explanations, they similarly seek to understand the underlying institutional processes and the feasible channels for retaining human intervention (Correa et al., 2026). The two studies conducted analyses from the perspectives of individual cognitive intervention and institutional transparency, respectively; together, they demonstrate that relying solely on technical transparency cannot establish sufficient trust, and that comprehensive interventions must take both individual differences and the organizational institutional context into account. In summary, enhancing algorithm literacy in the workplace is a multidimensional process: it requires the design of differentiated educational interventions tailored to individual differences (Silva et al., 2024), as well as the establishment of a transparency framework at the organizational level that incorporates institutional explanation and safeguards for human control (Correa et al., 2026). The findings indicate that effective algorithm literacy development should not be limited to popularizing technical principles;

rather, it should explore in depth the interaction between algorithms and organizational culture as well as individual experiences, thereby helping employees develop a stronger sense of control and trust within algorithmic environments.

4. Design of Algorithmic Systems: Political Science—From Reverse Engineering to Forward Engineering

When exploring human–machine co-design, it is crucial to understand how algorithmic systems are "designed." This sub-theme moves beyond mere technical implementation toward critical algorithmic research, focusing on how design constraints, pre-set problems, and authoritative systems pre-determine the social consequences of algorithmic systems. The research emphasizes a shift from "reverse engineering" (which attempts to open the black box) to "forward engineering" (which analyzes design documents and constraints), thereby revealing the roots of algorithmic bias and opacity and providing a theoretical basis for more responsible system design. Some studies have proposed a "forward engineering" research approach, advocating for the use of algorithm design constraint documents to analyze the logic underlying the generation of algorithmic social consequences. This perspective argues that pursuing a path of improvement focused solely on algorithmic transparency and bias mitigation has inherent limitations; it is also necessary to clarify the real-world problems that the algorithm aims to solve, the solutions selected, and the power system upon which it relies (Polack, 2020). In a related vein, research on the Wikipedia platform has found that various automated scripts and bot tools have become deeply embedded within the platform's organizational culture; new participants must become familiar with these algorithmic agents before they can engage in collaboration, reflecting that algorithms are not merely technical tools but also serve functions of organizational governance and cultural transmission (Geiger, 2017). Platform-level research has revealed the practical significance of algorithmic learning within organizational culture, while the forward engineering perspective demonstrates that this cultural embedding effect is already established during the algorithm design phase through problem definition and constraint conditions. Synthesizing these two types of research reveals that the various social impacts brought about by algorithms are already foreshadowed at the very beginning of the system design process. In summary, the design process of algorithmic systems is imbued with political and social presuppositions. Algorithmic applications in the workplace should not be viewed merely as efficiency tools; their design logic directly reflects the organization's power structure and value orientation. By analyzing design constraints from the perspective of "forward engineering" (Polack, 2020) and understanding the embedding process of algorithms through the lens of organizational culture (Geiger, 2017), managers can more deeply identify potential algorithmic biases and intervene during the design phase, thereby promoting the development of a more equitable, transparent, and ethically aligned human–machine collaborative environment.

5. Algorithm operability and calibration: Design of the prediction system

The application of algorithmic prediction in workplaces—such as in performance appraisal, recruitment, and policing—is often assumed to possess an inherent "operability," meaning that it can be directly translated into action. However, this sub-theme focuses on the process by which predictive results are transformed into actual actions; specifically, how designers use "calibration" to adjust statistical predictions into "actionable knowledge" that aligns with the cognition and needs of frontline users (e.g., managers and police officers). This reveals that human–machine collaboration is not a simple "data input–decision output" process, but rather a complex one characterized by human judgment and negotiation. Ethnographic research conducted based on Germany's predictive policing system challenges the prevailing perception that algorithmic prediction possesses inherent operability. The study found that system designers must undertake extensive calibration work, adjusting the scale, timing, and spatial scope of predictions in accordance with the practical needs of frontline staff, thereby transforming statistical outputs into actionable

knowledge (Heimstädt & Egbert, 2025). This conclusion echoes the findings of review studies focused on algorithmic systems, which propose that algorithms should be understood as an organic whole comprising both technical and social components (Hodges & Trace, 2023). Fieldwork further demonstrates how this holism is dynamically generated during the design phase: the statistical results produced by algorithms must undergo social interpretation and reconstruction by designers before they can be converted into operational instructions that frontline employees can execute. It is therefore evident that the operability of an algorithm is not an inherent attribute of the system; rather, it is the product of ongoing negotiation and co-construction between designers and end users. In summary, the successful implementation of algorithmic systems in the workplace depends heavily on the proactive construction of "operability" during the design phase (Heimstädt & Egbert, 2025). Through calibration, designers transform abstract statistical data into concrete action guidelines; this process profoundly shapes the essence of human–machine collaboration. Understanding this mechanism helps organizations recognize that introducing algorithmic systems is not merely a matter of technical deployment; it also involves redesigning work processes and decision-making logic. This requires fully considering the practical needs and cognitive habits of frontline employees to prevent algorithmic recommendations from becoming disconnected from actual operations.

6. The Socio-Cultural Embedding and Preservation of Algorithmic Systems: Transcending the Technical Black Box

Algorithmic systems are not isolated pieces of code; rather, they are deeply embedded within specific socio-cultural contexts, organizational structures, and historical settings. This sub-theme focuses on the holistic nature of algorithmic systems as products of social technology, exploring how these systems should be preserved to maintain their fairness and traceability, as well as how algorithms co-shape organizational cultures and media logics. The research emphasizes that to truly understand human–machine co-creation, it is necessary to move beyond the "black box" of technology and examine the role of algorithms within a broader social ecosystem. Some studies have developed multidimensional analytical frameworks, proposing that when preserving algorithmic systems in archival contexts, it is essential to simultaneously document both technical and social components; the algorithms discussed in public discourse are themselves a combination of these two types of elements (Hodges & Trace, 2023). An empirical study on Google image search results in Italy provides real-world evidence for this view: discriminatory image search results targeting immigrant groups do not stem solely from algorithmic logic, but are instead the result of a mutual reinforcement between local media reporting habits and algorithmic mechanisms (Ieracitano et al., 2024). This indicates that the effects produced by algorithms in work settings or social environments are, in many cases, the result of external social biases being amplified and solidified by algorithms through data feedback loops. Other studies call for a re-humanized examination of algorithmic systems, advocating for greater emphasis on human agency and social value within algorithm-dominated environments to counter the alienation caused by technological determinism (Ruckenstein, 2022). In summary, the sociocultural embeddedness of algorithmic systems determines their form of manifestation in the workplace. Whether it concerns the storage of algorithms, bias analysis, or human-centered redesign, technology must be understood as part of a social process (Hodges & Trace, 2023; Ieracitano et al., 2024; Ruckenstein, 2022). When implementing human–machine collaboration, organizations should not focus solely on algorithmic accuracy; they must also remain vigilant about the risk that external social biases may be amplified by algorithms through data feedback loops (Ieracitano et al., 2024). By adopting a multidimensional perspective that incorporates the social context, organizations can better manage algorithmic systems and foster a more inclusive and equitable human–machine collaboration ecosystem.

7. conclusion

Existing research has demonstrated that algorithmic systems have evolved within organizational environments from mere technical tools into key

forces that profoundly influence workplace culture, decision-making logic, and social interaction. The literature indicates that the implementation of algorithmic systems involves not only the technical dimensions of digital transformation and operational analytics (Emerson, 2019b), but is also deeply embedded within organizational culture and governance structures; for instance, how Wikipedia's automated infrastructure shapes expert culture and the socialization process for newcomers (Geiger, 2017). Further research points out that the operability of an algorithm is not an inherent attribute, but rather the result of active construction by designers through calibration practices (Heimstädt & Egbert, 2025); this construction process often presupposes specific problem frameworks and authority systems (Polack, 2020). Simultaneously, the use of terminology—such as "algorithm" versus "chatbot" —significantly influences users' trust in and willingness to adopt the system (Chacon et al., 2026); meanwhile, algorithmic bias and opacity may exacerbate the stigmatization of specific groups within public sector and media environments (Ieracitano et al., 2024), highlighting the complexity of algorithmic systems as socio-technical entities whose impact extends beyond mere technical efficacy to encompass social dimensions such as equity, accountability, and trust. Future research should move beyond the technical deconstruction of algorithms as "black boxes" and instead shift toward exploring the deeper mechanisms of human–machine collaboration and institutional design to address the challenges posed by algorithmic control. On the one hand, attention should be paid to the cultivation of algorithmic literacy; by integrating personalized experiences with information intervention (Silva et al., 2024), the public and employees can be helped to develop a rational understanding and attitude toward algorithmic systems, particularly in high-impact contexts such as digital media and public services. On the other hand, research should focus on "forward engineering" design approaches: starting from design constraints and predefined problems, algorithmic systems should be reimagined to address fundamental design flaws (Polack, 2020), rather than remaining merely at the level of improvements in transparency or bias mitigation. Furthermore, it is crucial to establish a layered transparency framework that encompasses micro-level informational conditions, meso-level relational dynamics, and macro-level institutional structures; by listening to the needs of end users—such as citizens and frontline police officers—through participatory design (Correa et al., 2026), transparency can be extended beyond technical interpretation to the institutional and relational levels. This approach, while preserving human control, can drive algorithmic systems toward a human–machine co-creation model that promotes human agency, shifting them from unidirectional control toward collaborative interaction.

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