

Article

Algorithmic Management and Employee Outcomes: Dual Effects of Control and Capability on Autonomy and Career Security

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Abstract

The increasing integration of artificial intelligence (AI) into organizational processes has accelerated the adoption of algorithmic management, reshaping work structures across labor-intensive service organizations. However, empirical evidence remains limited regarding the simultaneous control-oriented and developmental dimensions of AI-enabled management systems. This study examines how algorithmic control and AI-supported skill development influence perceived autonomy and career security among employees in hospitality organizations. Data were collected from 441 employees working in hotel organizations in Bavaria, Germany. The data were analyzed using exploratory factor analysis (EFA), confirmatory factor analysis (CFA), structural equation modeling (SEM), bootstrapped mediation analysis, and hierarchical regression. The results suggest that control-oriented and developmental dimensions of AI are associated with different aspects of employees' work experiences. Algorithmic control was negatively associated with perceived autonomy, whereas AI-supported skill development was positively associated with both perceived autonomy and career security. Perceived autonomy did not mediate the relationships between AI-related workplace conditions and career security, and digital literacy did not moderate the relationship between algorithmic control and perceived autonomy. The study contributes to research on algorithmic management and AI-enabled workplaces by highlighting the importance of analytically distinguishing between the control-oriented and developmental dimensions of AI when examining the organizational implications of AI-enabled management.

Keywords: algorithmic management; artificial intelligence; employee autonomy; career security; digital literacy; human capital development; hospitality organizations



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1. Introduction

The rapid integration of artificial intelligence (AI) into organizational processes is fundamentally transforming how work is structured, monitored, and evaluated (T. Xu et al., 2025; Vera et al., 2026; Phan et al., 2026). Within this transformation, algorithmic management has emerged as a dominant mode of coordination, relying on data-driven systems to regulate employee behavior, allocate tasks, and assess performance (Kinowska & Sienkiewicz, 2022; Chen et al., 2026). Although early research primarily conceptualized algorithmic management as a mechanism of digital surveillance and performance control,

contemporary scholarship increasingly frames it as a broader organizational governance system that raises questions extending beyond efficiency and monitoring. Rather than focusing exclusively on managerial control, recent research has examined how algorithmic systems influence transparency, explainability, procedural fairness, organizational trust, human oversight, professional discretion, employee resistance, and the perceived legitimacy of algorithmic decision-making (Jarrahi, 2018; Shin, 2021; Meijerink & Bondarouk, 2023). Collectively, these studies demonstrate that algorithmic management reshapes not only work processes but also the organizational conditions under which managerial authority is exercised.

While existing research has predominantly examined these dynamics in platform-based contexts such as gig economy services (Nhan & Thu, 2026; Hajiheydari & Soltani Delgosha, 2026), significantly less attention has been devoted to traditional sectors characterized by interpersonal service delivery and contextual flexibility. This limitation is particularly evident in labor-intensive service organizations, where work practices rely heavily on interpersonal interaction, contextual judgment, and adaptive decision-making (Bacter et al., 2025; Knežević et al., 2025a; Vujko et al., 2025b; Hao et al., 2026). This study addresses this gap by examining how algorithmic management shapes employee experiences in hospitality organizations. Unlike highly standardized platform-based environments (Bi et al., 2026), hospitality organizations often operate under conditions characterized by smaller organizational scales, multifunctional roles, interpersonal service delivery, varying levels of technological integration, and limited access to formal training and digital infrastructure (Vujko et al., 2025a). These characteristics create a unique tension between the increasing adoption of AI-driven systems and the traditionally autonomy-dependent nature of service work. Consequently, algorithmic control mechanisms—such as monitoring, automated decision-making, and performance standardization—may have qualitatively different implications in these settings than those documented in the existing literature (Dishop, 2026).

Despite these theoretical advances, empirical research has predominantly investigated these organizational dimensions separately. While studies have generated important insights into transparency, explainability, procedural fairness, organizational trust, human oversight, and related governance issues, considerably less attention has been devoted to examining how different organizational applications of AI jointly shape employee experiences within the same organizational environment. These perspectives also suggest that algorithmic management may influence employees through multiple psychological and organizational mechanisms. However, the present study focuses specifically on perceived autonomy because hospitality work requires employees to exercise continuous discretion while responding to heterogeneous guest needs and unpredictable service situations. In this context, perceived autonomy represents not only a fundamental psychological need but also an operational resource that enables employees to balance standardized organizational requirements with personalized service delivery. Accordingly, autonomy was selected as the focal psychological mechanism through which the organizational implications of AI-enabled management are examined in the present study.

Building on this rationale, the present study conceptualizes algorithmic management as comprising two complementary organizational dimensions rather than a single managerial mechanism. Specifically, it distinguishes between algorithmic control, through which AI introduces new forms of managerial oversight that may constrain employee autonomy (Zhao & Syed, 2026; Tu et al., 2026), and AI-supported skill development, through which AI facilitates learning, skill acquisition, and adaptation to evolving job requirements (Yin & Hoang, 2025; Cingillioglu & Schoettner, 2025). Examining these dimensions simultaneously makes it possible to determine whether they are associated with different employee

outcomes, particularly perceived autonomy and career security, thereby providing a more nuanced understanding of AI-enabled management in labor-intensive hospitality organizations (Yu et al., 2026).

This study contributes to the literature in several important ways. First, it extends the concept of algorithmic management beyond platform economies by examining its implications in labor-intensive hospitality organizations, thereby addressing a significant contextual gap in the literature. Second, it brings together control-oriented and developmental perspectives on AI within a single analytical framework, enabling a more differentiated examination of how control-oriented and developmental AI are associated with employee outcomes. Third, building on the autonomy-dependent nature of hospitality work, it examines perceived autonomy not only as a direct outcome but also as a potential, though not necessarily universal, mediating mechanism through which different dimensions of algorithmic management may influence employee outcomes. At the same time, it tests the moderating influence of digital literacy, whose effectiveness in mitigating structural constraints remains empirically uncertain. In doing so, the study responds to calls for more complex models of technology–work relationships that account for both organizational and individual-level dynamics, while recognizing that relationships between key constructs may vary across employee outcomes.

The central research question guiding this study is: How does algorithmic management influence perceived autonomy and career security among employees in hospitality organizations, and to what extent are these relationships mediated by autonomy and moderated by digital literacy? In line with this question, the primary objective of the study is to empirically examine the direct, mediating, and moderating relationships between algorithmic control, AI-supported skill development, perceived autonomy, and career security. By combining exploratory and confirmatory analytical approaches with structural equation modeling, the study seeks to provide a comprehensive understanding of how AI-driven systems shape both immediate work experiences and longer-term professional evaluations.

Although the empirical setting is rural Bavaria, the findings may also provide insights for rural hospitality contexts that share similar organizational characteristics. Some rural regions across Europe, including Serbia, exhibit features such as the predominance of small and medium-sized enterprises, limited human resource capacity, constrained access to formal training systems, and increasing pressure to adopt digital technologies (Riquito, 2026; Dowell et al., 2026). However, differences in labour-market institutions, ownership structures, digital infrastructure, and tourism systems may influence how algorithmic management is implemented and experienced across settings. Consequently, the findings should be interpreted as contextually informative rather than directly generalizable to other regions. Within these boundaries, the study contributes to understanding how AI-enabled management may shape employee experiences in labor-intensive hospitality organizations and provides a foundation for future comparative research across diverse organizational and geographical contexts.

2. Literature Review and Hypothesis Development

2.1. *The Dual Logic of Contemporary Algorithmic Management*

Early studies conceptualized algorithmic management primarily as a mechanism of digital monitoring and managerial control, emphasizing surveillance, performance measurement, and standardized task allocation within highly structured work environments (Kellogg et al., 2020; Knežević et al., 2025b; Zheng et al., 2025). As AI technologies have become increasingly integrated into organizational decision-making, however, the concept has evolved beyond its original emphasis on digital supervision. Contemporary research increasingly conceptualizes algorithmic management as a broader organizational gover-

nance system in which algorithmic systems not only monitor employee behavior but also participate in coordinating work processes, supporting decision-making, facilitating learning, and shaping organizational relationships (Ryan & Deci, 2000; Meijerink & Bondarouk, 2023; Moon et al., 2026).

Consistent with this broader perspective, recent studies have increasingly examined algorithmic management through diverse organizational and psychological perspectives, emphasizing organizational trust, procedural fairness, explainability, psychological safety, technological anxiety, human oversight, and the perceived legitimacy of algorithmic decision-making (Jarrahi, 2018; Shin, 2021; Meijerink & Bondarouk, 2023; Gagné et al., 2026). Collectively, this body of research suggests that employee responses to AI-enabled management emerge through complementary psychological and organizational mechanisms rather than a single explanatory pathway.

This evolution has given rise to two complementary organizational logics. The first is a control-oriented logic, whereby AI enhances managerial oversight through continuous monitoring, performance evaluation, and behavioral standardization. The second is a developmental logic, whereby AI functions as a resource that supports learning, capability development, and adaptation to changing work requirements. Rather than representing mutually exclusive perspectives, these two logics frequently coexist within the same organizational environment, creating simultaneous opportunities for organizational efficiency and employee development while also generating new tensions concerning autonomy, discretion, and professional judgment (Rosenqvist & Sjöberg, 2024; Chabanet & Noël Lemaître, 2025; Xavier & Korunka, 2025). Accordingly, contemporary algorithmic management should not be conceptualized solely as a mechanism of digital surveillance but as a broader organizational governance system capable of simultaneously constraining and enabling employee agency. Among the various mechanisms proposed in prior research, the present study focuses on perceived autonomy because it most directly captures how employees experience the balance between algorithmic guidance and professional discretion in their everyday work. Building on this rationale, the following sections develop hypotheses explaining the relationships among algorithmic management, perceived autonomy, and career security.

2.2. Algorithmic Control and Perceived Autonomy

Algorithmic control reflects the control-oriented logic of contemporary algorithmic management through which work is coordinated, monitored, and evaluated using data-driven technologies (Kellogg et al., 2020; Zheng et al., 2025). Unlike traditional supervisory practices, algorithmic systems often operate through automated decision-making processes that reduce transparency and limit employees' ability to understand or influence evaluation criteria (Moon et al., 2026). Although previous studies have shown that algorithmic management may influence employees through multiple mechanisms, including organizational trust, procedural fairness, explainability, and psychological safety, the present study focuses on perceived autonomy because algorithmic control most directly shapes employees' discretion over work activities, making autonomy a direct psychological consequence of this organizational process. The relevance of this relationship is amplified in hospitality organizations, where employees routinely exercise professional judgment while responding to heterogeneous guest needs. From a theoretical perspective, such forms of control directly challenge the notion of autonomy, a central component of self-determination theory (Ryan & Deci, 2000). Autonomy refers to the extent to which individuals experience freedom, discretion, and control over their work activities (Gagné et al., 2026). In environments where algorithmic systems dictate work pace, task allocation, and performance assessment,

employees are likely to perceive a reduction in discretionary authority and professional judgment (Chabanet & Noël Lemaître, 2025; Xavier & Korunka, 2025).

Within this organizational context, effective service delivery depends on continuous interpersonal interaction, situational flexibility, service personalization, and context-sensitive decision-making (Rosenqvist & Sjöberg, 2024; Mattila et al., 2025). Unlike manufacturing or highly standardized administrative settings, employee autonomy is not only a psychological resource but also a prerequisite for adapting service delivery to heterogeneous guest expectations and unpredictable service situations (Lashley, 1995). Consequently, the imposition of standardized, algorithm-driven procedures may conflict with the inherently adaptive nature of hospitality work, leading to diminished perceptions of autonomy. Empirical evidence from digital labor platforms likewise indicates that algorithmic management constrains worker agency by limiting employees' influence over work processes and decisions (Kellogg et al., 2020). Based on these arguments, the following hypothesis is proposed:

H1. *Algorithmic control negatively affects perceived autonomy.*

2.3. AI-Supported Skill Development and Perceived Autonomy

Complementing the control-oriented logic discussed above, the developmental logic of contemporary algorithmic management conceptualizes AI as a resource that strengthens employees' capabilities through learning, guidance, and continuous adaptation (Brynjolfsson & McAfee, 2014; Liu & Li, 2025). From the perspective of human capital theory, investments in skill development increase individuals' productivity, adaptability, and perceived value within the labor market (Becker, 1993). Although prior research has identified several mechanisms through which AI-supported practices may influence employees, including organizational support, trust, self-efficacy, and technology acceptance, the present study emphasizes perceived autonomy because developmental AI primarily expands employees' capacity to exercise informed judgment and independent decision-making during everyday work. When AI functions as a supportive rather than controlling system, it enhances employees' knowledge and professional competence, strengthening their sense of control over work activities (Q. Zhou et al., 2024; Li & Zong, 2026; Ali et al., 2026). By providing informational resources rather than behavioral constraints, AI enables employees to act more independently and confidently in complex service situations (Kumar & Mittal, 2024; Y. Xu et al., 2026).

This perspective aligns with research suggesting that digital technologies can enhance autonomy when they are perceived as enabling rather than controlling (Meijerink & Bondarouk, 2023). The developmental role of AI may be particularly relevant in hospitality organizations, where employees frequently perform multifunctional roles, rely heavily on experiential learning, and often have limited access to highly formalized training systems. In such environments, AI-supported learning tools may complement experiential knowledge by providing real-time guidance and opportunities for capability development, thereby strengthening employees' confidence in exercising professional discretion. Recent evidence from the hospitality sector further indicates that experience-based learning and employees' self-efficacy contribute to the development of professional competencies, suggesting that AI-supported developmental practices are more likely to complement these learning processes than replace them (Qin et al., 2025; Lochner et al., 2025; Khuadthong et al., 2025). Accordingly, the following hypothesis is proposed:

H2. *AI-supported skill development positively affects perceived autonomy.*

2.4. AI-Supported Skill Development and Career Security

The relationship between technological change and career outcomes has been widely discussed in the literature on employability and labor market dynamics (Hanci & Gok Metin, 2026). In contexts characterized by rapid digital transformation, employees' perceptions of career security are increasingly linked to their ability to acquire and apply relevant skills (Fugate et al., 2004; De Cuyper et al., 2008). AI-supported skill development plays a crucial role in this process by enabling employees to adapt to evolving job requirements through ongoing learning and capability development (Poljsak-Rosinski & Roedenbeck, 2025). This relationship is particularly relevant in hospitality organizations, where career security may depend even more strongly on continuous skill adaptation because service quality relies heavily on employees' ability to respond effectively to heterogeneous customer expectations. From a human capital perspective, the accumulation of technologically relevant competencies enhances individuals' perceived employability and long-term career prospects (Brynjolfsson & McAfee, 2014). Employees who perceive AI as a tool that contributes to their professional growth are more likely to feel confident about their future within the organization and the broader labor market (Turčinović et al., 2025; P. Zhou et al., 2026). Furthermore, digital skill development may reduce uncertainty associated with technological change by increasing employees' ability to navigate and utilize AI systems effectively. As employees become more confident in applying these capabilities, they are also more likely to perceive stronger career stability and future advancement opportunities (Kholifah et al., 2025; Clorion et al., 2025). Based on these considerations, the following hypothesis is proposed:

H3. *AI-supported skill development positively affects career security.*

2.5. Perceived Autonomy and Career Security

Autonomy has traditionally been associated with positive work-related outcomes, including job satisfaction, motivation, and well-being (Ryan & Deci, 2000). Although career-related evaluations may also be shaped by mechanisms such as organizational support, trust, perceived fairness, or broader labor market conditions, perceived autonomy remains theoretically relevant because it reflects employees' day-to-day experience of exercising discretion at work. These day-to-day work experiences may subsequently influence broader evaluations of career stability, although the strength of this relationship may vary in technology-mediated work environments (Belias et al., 2015; Ignjatović Pertini & Vujko, 2026). Nevertheless, the relationship between autonomy and career security may not be straightforward. While autonomy reflects immediate, task-level experiences, career security represents a broader, future-oriented evaluation influenced by structural factors such as employability, skill relevance, and labor market conditions (Hanci & Gok Metin, 2026). This distinction is especially relevant in hospitality organizations, where employees continuously balance standardized organizational procedures with contextual judgment, interpersonal interaction, and discretionary responses to diverse customer needs. Previous hospitality research likewise emphasizes the importance of job design, interpersonal relationships, and organizational context in shaping employees' discretionary work behaviors (Lin & Mattila, 2010; Redmond & Sharafizad, 2020).

As technological change reshapes job requirements, employees may increasingly base their career expectations on their perceived ability to adapt rather than solely on their current level of autonomy (Do et al., 2025; Ho & Le, 2026; Testa et al., 2026). Despite these potential complexities, existing theoretical frameworks generally posit a positive relationship between autonomy and broader evaluative outcomes. Accordingly, the following hypothesis is proposed:

H4. *Perceived autonomy positively affects career security.*

2.6. The Mediating Role of Perceived Autonomy

Mediation mechanisms are central to understanding how organizational conditions translate into broader employee outcomes (Lee & Roh, 2026). Although prior research has proposed several psychological mechanisms linking AI-enabled management to employee outcomes, including organizational trust, perceived fairness, psychological safety, and perceived organizational support, self-determination theory identifies autonomy as a central mechanism through which employees interpret their experience of exercising discretion in everyday work (Ryan & Deci, 2000). In this framework, work environments that support or constrain autonomy are expected to indirectly shape higher-order outcomes, including perceptions of career stability (Bai et al., 2025; Maiti et al., 2025).

The relevance of perceived autonomy becomes especially evident in hospitality organizations, where service quality depends not only on compliance with standardized procedures but also on employees' ability to exercise discretion during guest interactions (Edeh et al., 2022). Unlike more standardized work settings, hospitality employees continuously respond to heterogeneous customer needs and unpredictable service situations (Pizam & Shani, 2009). Consequently, AI-enabled algorithmic management may influence employee outcomes not only by regulating task execution but also by shaping the degree of discretion employees retain when responding to diverse service situations. Accordingly, perceived autonomy is expected to mediate the relationship between AI-enabled work experiences and broader career-related evaluations.

Algorithmic control, by limiting discretion and increasing monitoring, may reduce perceived autonomy, which in turn could negatively influence career security (Chabanet & Noël Lemaître, 2025). Conversely, AI-supported skill development may enhance autonomy by increasing competence and decision-making capacity, thereby contributing to more positive career evaluations (Yan et al., 2026). Taken together, these arguments suggest that perceived autonomy may function as an intervening mechanism linking both control-oriented and developmental dimensions of AI with career-related outcomes. Accordingly, the following hypotheses are proposed:

H5. *Perceived autonomy mediates the relationship between algorithmic control and career security.*

H6. *Perceived autonomy mediates the relationship between AI-supported skill development and career security.*

2.7. The Moderating Role of Digital Literacy

Digital literacy represents an individual-level capability that reflects the ability to understand, use, and interact effectively with digital technologies (Mainz et al., 2025). Prior research suggests that higher levels of digital literacy may influence how employees perceive and respond to technological systems, potentially mitigating negative effects associated with digital control mechanisms (van Laar et al., 2020). From a competence-based perspective, digitally literate employees may be better equipped to interpret algorithmic outputs, understand system logic, and adapt their behavior accordingly (Wang & Xu, 2026). The theoretical relevance of this capability is particularly pronounced in hospitality organizations, where employees continuously combine standardized operational procedures with discretionary interpersonal service (Pizam & Shani, 2009; Edeh et al., 2022). Even when algorithmic systems prescribe tasks or workflows, employees remain responsible for interpreting guest needs, adapting service encounters, and exercising situational judgment (Lin & Mattila, 2010; Redmond & Sharafizad, 2020). Consequently, digital literacy may shape not only employees' technical ability to use AI systems but also their capacity to

integrate algorithmic guidance without experiencing equivalent reductions in perceived autonomy (Wang & Xu, 2026).

This could reduce uncertainty and increase perceived control, thereby weakening the negative relationship between algorithmic control and autonomy (van Zoonen et al., 2025; Rahman & Liang, 2026). However, the extent to which digital literacy can offset the organizational constraints associated with algorithmic management remains an open empirical question. Because hospitality work inherently requires contextual decision-making and personalized interactions, whether digital literacy can preserve autonomy under algorithmic management becomes a theoretically important question rather than merely an individual difference (Radović et al., 2025). In contexts where algorithmic management is highly standardized and prescriptive, individual capabilities may have limited influence on perceived autonomy (Cristofaro & Bañón-Gomis, 2026). Based on these considerations, the following hypothesis is proposed:

H7. *Digital literacy moderates the relationship between algorithmic control and perceived autonomy.*

The conceptual framework of the study is presented in Figure 1. The model illustrates the direct relationships between algorithmic control, AI-supported skill development, perceived autonomy, and career security, as well as the hypothesized mediating and moderating mechanisms. Algorithmic control is expected to negatively influence perceived autonomy (H1), while AI-supported skill development is hypothesized to exert a positive effect on both perceived autonomy (H2) and career security (H3). Perceived autonomy is further proposed to positively influence career security (H4). In addition to direct effects, the model incorporates two mediation paths in which perceived autonomy is expected to mediate the relationships between algorithmic control and career security (H5) and between AI-supported skill development and career security (H6). Finally, digital literacy is introduced as a moderating variable, hypothesized to influence the strength of the relationship between algorithmic control and perceived autonomy (H7).

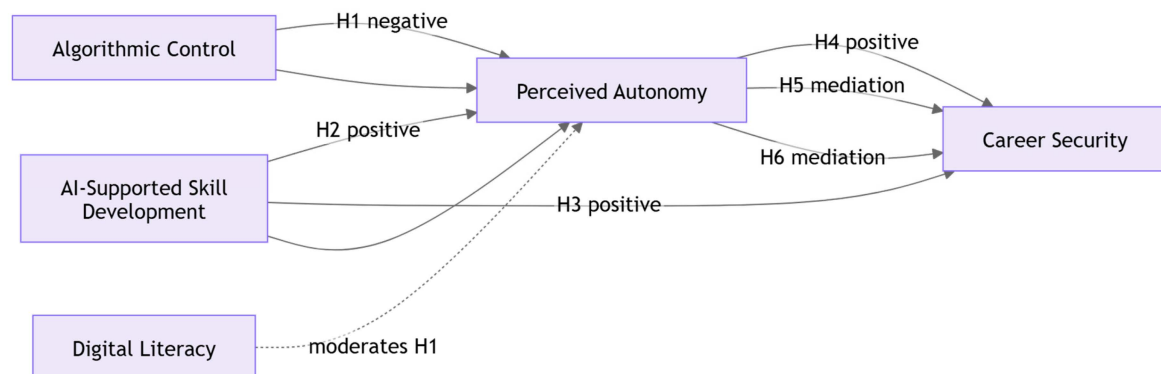


Figure 1. Conceptual Framework with Direct, Mediating, and Moderating Effects.

3. Materials and Methods

The empirical data were collected over a twelve-month period, from March 2025 to March 2026, within rural hospitality settings in Bavaria, Germany (Oppermann, 1996). The study focused on small- and medium-sized hotels operating in rural and semi-rural areas, where service delivery is characterized by close guest interaction, multifunctional roles, and a strong reliance on experiential knowledge. Data were gathered using a structured questionnaire administered exclusively to hotel employees. The target population consisted of staff members directly involved in daily operational activities, including front-office, service, and support roles. Particular attention was given to employees who were exposed

to AI-supported systems and elements of algorithmic management in their work environment. Within the participating hotels, these included AI-enabled technologies used for employee coordination, task allocation, performance monitoring, decision support, and digital learning or training where such systems were implemented. Rather than focusing on a single technological application, the study examined employees' perceptions of AI-enabled managerial practices across these organizational functions. Respondents were therefore selected on the basis that they had direct experience with AI-supported managerial practices in their daily work, encompassing both control-oriented and developmental applications of artificial intelligence.

Data collection was conducted through direct field visits by the three members of the research team. A total of 97 small family-owned hotels located in rural areas of Bavaria participated in the study. Access to employees was facilitated through collaboration with hotel management and professional networks within the Bavarian hospitality sector. Researchers approached employees individually, explained the purpose of the study, and invited them to participate. Whenever possible, questionnaires were completed immediately on site. Employees who preferred to respond later received an electronic version of the questionnaire by e-mail. In total, 468 questionnaires were distributed, resulting in 441 valid responses retained for analysis (response rate: 94.2%). Participation was voluntary and anonymous, and all respondents were informed about the academic purpose of the study.

To ensure data quality, attention checks were included in the questionnaire, and incomplete or inconsistent responses were excluded from the final dataset. Because the participating hotels were relatively small and the sample was drawn from 97 different establishments, the data reflect employee perceptions across a broad range of organizational environments rather than repeated observations from only a small number of hotels. The extended data collection period allowed for the inclusion of employees across different operational phases, including variations in seasonal demand, which are typical for rural hospitality settings. This approach enhanced contextual validity by capturing employee experiences across varying operational conditions.

The demographic and professional profile of the sample reflects the structural characteristics of the rural hospitality workforce in Bavaria, providing a relevant empirical basis for examining the implications of algorithmic management in this context. The gender distribution indicates a moderately female-dominated workforce, with women accounting for 56.7% of respondents, while men represent 43.3%. This pattern is consistent with established sectoral dynamics in hospitality, where service-oriented and operational roles are often more strongly represented by female employees. The age structure reveals a concentration of respondents within the core working-age population, particularly between 26 and 45 years (54.2% combined), with the largest individual group being those aged 36–45 (27.4%). This suggests a workforce characterized by professional maturity and accumulated experience. At the same time, the presence of older cohorts (46–55: 19.3%; 56–65: 11.3%; over 66: 3.9%) indicates a relatively stable employment structure with extended tenure, which is typical for rural labor markets where workforce mobility is limited and long-term employment relationships are more common. The comparatively smaller share of younger employees (18–25: 11.3%) may reflect constraints in attracting new labor to rural hospitality settings.

The educational profile is dominated by vocational and applied higher education, with the majority of respondents holding a college or higher school qualification (56.7%), followed by bachelor's degrees (26.3%). Secondary education accounts for a relatively small proportion (7.7%), while master's-level qualifications remain limited (9.3%). This distribution reflects the operational orientation of the sector, where practical competencies and applied training are prioritized over advanced academic specialization. Work expe-

rience is broadly distributed, with a notable concentration in the mid-career categories of 6–15 years (32.7%) and 1–5 years (31.5%), alongside a substantial proportion of highly experienced employees with more than 16 years in the industry (28.1%). The relatively low proportion of newcomers (less than 1 year: 7.7%) reinforces the interpretation of a stable but potentially aging workforce, which may have implications for adaptability to new managerial technologies. The distribution of job positions further confirms the operational nature of the sample. Housekeeping (31.3%) and food and beverage roles (25.6%) constitute the largest segments, followed by front desk positions (19.3%). Administrative (14.1%) and managerial roles (9.8%) are less represented, indicating that the findings primarily capture the perceptions of employees directly engaged in service delivery and daily operational tasks. This is particularly relevant for the study of algorithmic management, as these roles are typically the most exposed to digital monitoring, scheduling systems, and AI-supported decision-making processes.

Digital literacy levels appear relatively limited across the sample. A majority of respondents report low or very low digital skills (53.3%), while only a small proportion indicate high (14.7%) or very high (3.4%) levels of digital competence. A moderate level is reported by 28.6% of respondents. This distribution highlights a significant gap between the increasing digitalization of management practices and the existing capabilities of the workforce. In the context of rural Bavarian hospitality, where organizational structures are often resource-constrained and less technologically advanced, such limitations may pose substantial barriers to the effective implementation of algorithmic management systems. Overall, the sample reflects a workforce that is operationally oriented, moderately experienced, and relatively stable, yet characterized by limited digital competencies. These features are highly relevant for understanding the potential challenges and constraints associated with the adoption of AI-driven management practices in rural hospitality environments, particularly in terms of employee adaptation, perceived autonomy, and the alignment between technological systems and human capital capacities.

The initial questionnaire consisted of 35 measurement items designed to capture different aspects of employees' experiences with artificial intelligence in the workplace. All items were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to factor extraction, item purification was conducted based on factor loading criteria. Items with factor loadings below the threshold of 0.50 were excluded because they did not contribute adequately to the intended latent construct or exhibited insufficient psychometric performance, consistent with established recommendations for exploratory factor analysis (Hair et al., 2010; Field, 2018). Following this purification process, the remaining items were retained for subsequent analyses. Appendix A presents the complete set of initial questionnaire items together with their retention status following exploratory factor analysis, thereby providing full transparency regarding the item purification process.

The development of the measurement instrument was grounded in the prior literature on algorithmic management, digital work environments, human capital development, and employee autonomy. Items capturing AI-driven monitoring, decision-making, and performance evaluation were informed by research on algorithmic control and platform-based management systems (Kellogg et al., 2020; Meijerink & Bondarouk, 2023). Statements related to learning, feedback, and competence development were derived from studies on human capital theory and digital skill formation in technology-mediated work contexts (Brynjolfsson & McAfee, 2014; Liu & Li, 2025). Items addressing employee discretion, flexibility, and professional judgment were informed by theoretical perspectives on autonomy and self-determination in organizational settings (Ryan & Deci, 2000). Finally, items related to perceptions of professional stability, employability, and future career prospects were

developed in line with research on career security and employability in evolving labour markets (Fugate et al., 2004; Hanci & Gok Metin, 2026).

Although several constructs describe related aspects of employees' experiences with AI-enabled work, individual items were assigned to constructs on the basis of their underlying theoretical definitions and were subsequently validated through exploratory and confirmatory factor analyses. This theoretically grounded approach ensured that the measurement instrument captured employees' perceptions of AI-enabled managerial practices across a broad range of organizational applications, including coordination, monitoring, decision support, and learning-related functions, while allowing the underlying factor structure to emerge empirically through subsequent analysis. Examples of the measurement items are presented in Appendix A, providing greater transparency regarding the AI-enabled managerial practices evaluated by respondents.

Data Analysis Procedure

The data analysis was conducted using a multi-step approach combining exploratory and confirmatory techniques to ensure the robustness and validity of the measurement and structural models. Statistical analyses were performed using IBM SPSS Statistics version 28.0 and IBM SPSS AMOS version 28.0 (IBM Corp., Armonk, NY, USA). Initially, the suitability of the dataset for factor analysis was assessed. Sampling adequacy and intercorrelations among variables were evaluated using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's Test of Sphericity. These procedures were applied to confirm that the dataset met the necessary assumptions for factor extraction.

Harman's single-factor test was conducted to assess the potential impact of common method variance. All measurement items were entered into an exploratory factor analysis using an unrotated solution. The results indicate that the first factor does not account for the majority of the variance, suggesting that common method bias is unlikely to represent a significant threat to the validity of the findings. To provide a more robust assessment of common method variance, a Common Latent Factor (CLF) procedure was also performed within the confirmatory factor analysis framework. A latent factor was specified to load on all observed indicators, allowing the estimation of potential method effects. The standardized factor loadings obtained with and without the CLF were subsequently compared to evaluate the potential influence of common method variance. Following this, an exploratory factor analysis (EFA) was conducted using the maximum likelihood extraction method. Given the theoretical expectation that latent constructs are correlated, an oblique rotation (direct oblimin) was applied. The number of factors retained was determined based on the Kaiser criterion (eigenvalues greater than 1), supported by interpretability considerations. The EFA was used to identify the underlying factor structure and to assess the loading patterns of individual items.

Subsequently, confirmatory factor analysis (CFA) was performed using AMOS to validate the measurement model. Model fit was evaluated using multiple fit indices, including the chi-square statistic (χ^2), the χ^2/df ratio, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), Tucker–Lewis index (TLI), comparative fit index (CFI), root mean square residual (RMR), and root mean square error of approximation (RMSEA) with PCLOSE. These indices were used collectively to assess the adequacy of the measurement model. Reliability and validity of the constructs were further examined. Internal consistency was assessed using composite reliability (CR). Convergent validity was evaluated through the average variance extracted (AVE), while discriminant validity was assessed using the Fornell–Larcker criterion and the heterotrait–monotrait ratio (HTMT).

After establishing the measurement model, structural equation modeling (SEM) was employed to test the hypothesized relationships among constructs. Standardized path

coefficients, standard errors, critical ratios, and significance levels were used to evaluate direct effects. To examine indirect effects, mediation analysis was conducted within the SEM framework using bootstrapping procedures with bias-corrected confidence intervals. This approach allowed for the assessment of whether perceived autonomy functions as a mediating variable between exogenous and endogenous constructs. In addition, moderation analysis was performed to test the moderating role of digital literacy. Prior to creating the interaction term, predictor variables were mean-centered to reduce multicollinearity. The interaction term was computed as the product of the centered variables. Hierarchical regression analysis was then conducted, with the dependent variable regressed on the main effects and the interaction term. The significance of the interaction coefficient was used to determine the presence of a moderating effect. Finally, the explanatory power of the models was evaluated using the coefficient of determination (R^2), indicating the proportion of variance explained in the endogenous constructs.

4. Results

The Kaiser–Meyer–Olkin (KMO) value of 0.941 indicates a very high level of sampling adequacy, confirming that the dataset contains sufficient shared variance for reliable factor extraction. Bartlett’s Test of Sphericity is statistically significant ($\chi^2 = 7236.353$, $df = 351$, $p < 0.001$), rejecting the null hypothesis of an identity correlation matrix. This demonstrates that the variables are adequately intercorrelated and suitable for factor analysis. Collectively, these results support the application of exploratory factor analysis and the identification of a stable underlying factor structure.

The results presented in Table 1 indicate a clear four-factor structure based on the Kaiser criterion (eigenvalues > 1). The first factor explains 28.08% of the total variance, followed by the second factor with 21.59%, while the third and fourth factors contribute 8.68% and 6.94%, respectively. Together, the four retained factors account for 65.29% of the total variance in the initial solution. After extraction, the cumulative explained variance amounts to 59.19%, which remains within acceptable thresholds for social science research, particularly given the complexity of latent constructs in organizational and behavioral studies. The relatively strong contribution of the first two factors suggests a pronounced underlying structure, while the additional factors provide incremental explanatory power, capturing more nuanced dimensions of the data. The rotated solution further redistributes variance across factors, indicating a more balanced and interpretable structure, which is consistent with the assumption of correlated latent constructs. Overall, the results support the retention of a four-factor model and indicate a stable latent structure suitable for subsequent confirmatory analysis.

Table 1. Total Variance Explained (Maximum Likelihood Extraction with Rotation).

Factor	Initial Eigenvalue	% of Variance	Cumulative (%)	Extracted Variance (%)	Cumulative Extracted (%)
1	7.583	28.084	28.084	25.551	25.551
2	5.828	21.585	49.669	21.002	46.553
3	2.344	8.680	58.349	7.170	53.724
4	1.874	6.942	65.291	5.469	59.192

The pattern matrix presented in Table 2 indicates a clear and well-defined four-factor structure corresponding to the proposed constructs. Items related to algorithmic control load strongly and negatively on the first factor (loadings ranging from -0.808 to -0.868), reflecting a coherent dimension capturing various aspects of AI-driven monitoring, decision-making, and work standardization. The second factor, AI-supported skill

development, is characterized by high positive loadings (0.744–0.858), indicating a consistent perception of AI as a facilitator of learning, competence enhancement, and long-term development. The third factor, perceived autonomy, shows substantial loadings across all associated items (0.699–0.773), suggesting a stable construct capturing employees' sense of control, flexibility, and discretionary authority in their work. The fourth factor, career security, is also well-defined, with moderate to strong loadings (0.510–0.676), reflecting perceptions of professional stability, advancement opportunities, and employability.

Table 2. Pattern Matrix.

	Factor			
	Algorithmic Control	AI-Supported Skill Development	Perceived Autonomy	Career Security
Work monitoring	−0.814	−0.008	−0.036	−0.023
Algorithmic decision-making	−0.808	0.020	−0.049	0.047
Opaque criteria	−0.861	−0.043	0.008	−0.018
Reduced discretion	−0.861	−0.022	0.022	−0.002
Algorithm priority	−0.831	0.074	−0.011	−0.049
Work pace	−0.868	−0.024	0.038	0.027
Digital evaluation	−0.815	0.017	−0.004	0.011
Perceived Autonomy	−0.017	−0.061	0.748	0.067
Personalized feedback	−0.007	0.003	0.749	0.034
Professional control	−0.019	−0.007	0.773	−0.029
Work flexibility	0.049	0.085	0.699	−0.078
AI support	0.010	−0.015	0.720	0.034
Discretionary authority	0.014	0.031	0.719	−0.020
Recognition of experience	0.020	0.023	0.756	0.002
Skill development	0.046	0.858	0.003	−0.034
Personalized feedback	0.013	0.835	0.004	0.009
Faster learning	−0.058	0.744	0.068	0.055
Potential identification	−0.002	0.826	0.008	−0.018
Competence enhancement	−0.002	0.769	−0.043	0.112
Quality standards	−0.027	0.806	0.023	−0.026
Long-term development	0.006	0.824	−0.014	−0.006
Career security	0.033	0.035	−0.004	0.672
Career advancement path	−0.004	−0.047	0.001	0.676
Market competitiveness	0.009	0.036	−0.086	0.605
Technological employability	−0.025	0.060	0.028	0.510
Future advancement	0.021	−0.002	0.018	0.673
Professional stability	−0.029	−0.017	0.074	0.622

Cross-loadings are minimal and do not exceed acceptable thresholds, supporting discriminant validity among the constructs. The negative factor loadings observed for Algorithmic Control reflect the arbitrary orientation of the latent factor in exploratory factor analysis and do not affect the substantive interpretation of the construct. In subsequent confirmatory factor analysis and structural equation modeling, the construct was oriented so that higher latent scores consistently represent higher levels of algorithmic control.

The measurement model demonstrates a very good fit to the data. The chi-square is non-significant ($\chi^2 = 300.228$, $df = 318$, $p = 0.755$), and the χ^2/df ratio is below 1 (0.944), indicating minimal discrepancy between the model and the observed covariance matrix. Absolute fit indices are strong (GFI = 0.952; AGFI = 0.943; RMR = 0.015), while incremental indices exceed recommended thresholds (NFI = 0.959; TLI = 1.003; CFI = 1.000). The RMSEA is effectively zero (RMSEA = 0.000; PCLOSE = 1.000), confirming a close fit. Parsimony-adjusted measures (PNFI = 0.869; PCFI = 0.906) also support model adequacy. The measurement model shows a high level of fit, indicating that the observed indicators reliably represent the underlying latent constructs. While the fit indices indicate an excellent model fit, such results should be interpreted with caution given the sample size and model specification. Accordingly, the present findings should be interpreted as providing support for the proposed measurement and structural models within the present sample rather than as definitive evidence of model generalizability.

The high level of model fit may partly reflect the use of theoretically well-defined constructs adapted from the established literature and the specification of a parsimonious four-factor measurement model without correlated error terms or unnecessary cross-loadings. Although several indicators capture related aspects of the same latent constructs, the evidence for convergent and discriminant validity (CR, AVE, Fornell–Larcker criterion, and HTMT ratios) suggests that they represent complementary rather than redundant dimensions of the underlying concepts.

As shown in Table 3, all constructs exhibit strong composite reliability (CR > 0.70), indicating a high level of internal consistency within the measurement model. The average variance extracted (AVE) values exceed the recommended threshold of 0.50 for Algorithmic Control, AI-Supported Skill Development, and Perceived Autonomy, supporting convergent validity. Although the AVE for Career Security (0.472) is slightly below the threshold, it remains acceptable due to its adequate CR and consistent factor loadings. These findings confirm the convergent validity of the measurement model.

Table 3. Composite Reliability (CR) and Average Variance Extracted (AVE).

Construct	CR	AVE
Algorithmic Control (F1)	0.941	0.696
AI-Supported Skill Development (F2)	0.923	0.632
Perceived Autonomy (F3)	0.898	0.559
Career Security (F4)	0.842	0.472

As shown in Table 4, the square root of AVE for each construct exceeds its correlations with other constructs, satisfying the Fornell–Larcker criterion and indicating adequate discriminant validity. The largest absolute inter-construct correlation is observed between Algorithmic Control and Perceived Autonomy ($|r| = 0.550$). Despite this association, the square root of the AVE for each construct exceeds the corresponding inter-construct correlations, supporting discriminant validity.

The HTMT ratios presented in Table 5 are all below the conservative threshold of 0.85, further confirming discriminant validity among the constructs. The highest HTMT value (0.628) is still well within acceptable limits. These results indicate that the constructs are empirically distinct, supporting the discriminant validity of the measurement model.

Table 4. Discriminant Validity (Fornell–Larcker Criterion).

Construct	F1	F2	F3	F4
Algorithmic Control (F1)	0.834	0.040	0.550	0.060
AI-Supported Skill Development (F2)	0.040	0.795	0.420	0.370
Perceived Autonomy (F3)	0.550	0.420	0.748	0.260
Career Security (F4)	0.060	0.370	0.260	0.687

Note: Diagonal values represent $\sqrt{\text{AVE}}$.

Table 5. Discriminant Validity (HTMT Ratio).

Construct	F1	F2	F3	F4
Algorithmic Control (F1)	—	0.048	0.628	0.071
AI-Supported Skill Development (F2)	0.048	—	0.487	0.429
Perceived Autonomy (F3)	0.628	0.487	—	0.301
Career Security (F4)	0.071	0.429	0.301	—

Harman’s single-factor test was conducted to assess the potential impact of common method variance. All measurement items were entered into an exploratory factor analysis using an unrotated solution. The results indicate that the first factor accounted for 28.08% of the total variance, which is well below the commonly accepted threshold of 50%, suggesting that common method variance is unlikely to represent a significant threat to the validity of the findings. To provide a more rigorous assessment, a Common Latent Factor (CLF) procedure was additionally conducted. The inclusion of the CLF produced only minimal changes in standardized factor loadings, with differences ranging from -0.10 to 0.06 , well below the recommended threshold of 0.20 . Furthermore, the substantive construct loadings remained substantially stronger than the corresponding CLF loadings across the measurement model, and no meaningful changes in model fit indices or structural parameter estimates were observed following the inclusion of the CLF. Taken together, these findings indicate that common method variance is unlikely to have materially influenced the measurement model or biased the estimated structural relationships, thereby providing additional support for the robustness of the study’s findings.

The structural model shows a very good fit to the data. The chi-square is non-significant ($\chi^2 = 302.042$, $df = 320$, $p = 0.757$), and the χ^2/df ratio is below 1 (0.944), indicating minimal discrepancy between the model and the observed data. Absolute fit indices are strong ($GFI = 0.952$; $AGFI = 0.943$; $RMR = 0.018$), while incremental indices exceed recommended thresholds ($NFI = 0.959$; $TLI = 1.003$; $CFI = 1.000$). The RMSEA is effectively zero ($RMSEA = 0.000$; $PCLOSE = 1.000$), supporting a close fit. Parsimony-adjusted indices ($PNFI = 0.874$; $PCFI = 0.912$) further confirm model adequacy. These results indicate that the structural model provides a robust representation of the relationships among the constructs.

While the fit indices indicate an excellent model fit, such results should be interpreted with caution given the sample size and model specification. Exceptionally high fit indices may partly reflect the use of theoretically well-defined constructs, the exclusion of poorly performing indicators during the measurement purification process, and the relatively parsimonious specification of the measurement model. At the same time, because both exploratory and confirmatory analyses were conducted on the same dataset, the observed level of fit should not be interpreted as evidence that the model is universally applicable. Independent validation using different samples would provide an important direction for future research.

As shown in Figure 2, the measurement component demonstrates strong and consistent factor loadings across all constructs.

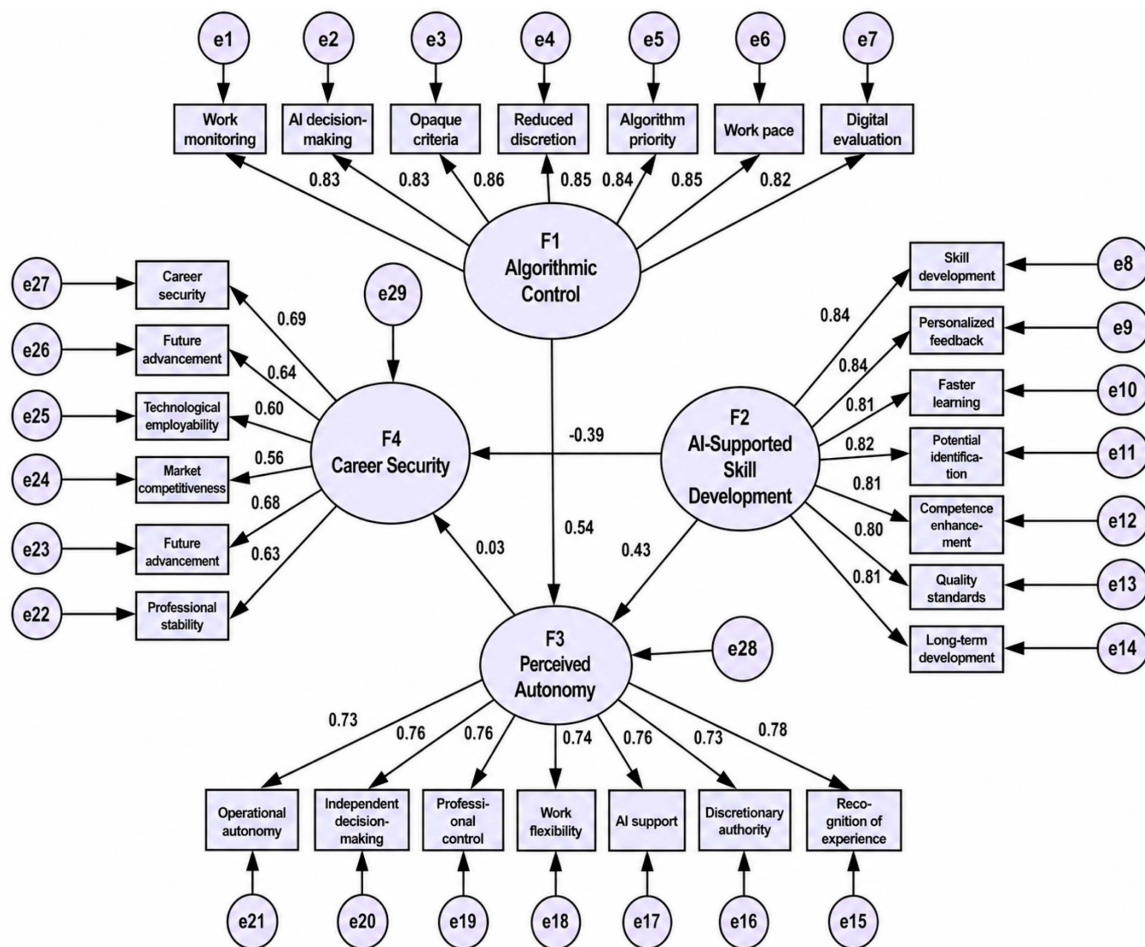


Figure 2. Structural Equation Model (SEM).

Indicators of Algorithmic Control (F1) load highly (0.82–0.86), confirming a well-defined construct capturing monitoring, decision-making, and control intensity. AI-Supported Skill Development (F2) is similarly well represented, with loadings ranging from 0.80 to 0.84, indicating coherent measurement of skill enhancement and learning support. Perceived Autonomy (F3) shows stable loadings (0.73–0.78), reflecting consistent operationalization of autonomy-related dimensions. In contrast, Career Security (F4) exhibits comparatively lower but acceptable loadings (0.56–0.69), suggesting a somewhat weaker yet still adequate measurement structure. The structural relationships indicate that Algorithmic Control (F1) has a statistically significant negative effect on Perceived Autonomy (F3) ($\beta = -0.39$), while no direct effect on Career Security (F4) is specified in the model. At the same time, AI-Supported Skill Development (F2) positively influences Perceived Autonomy (F3) ($\beta = 0.43$), highlighting its role in enhancing employees' sense of control over their work. The path from Perceived Autonomy (F3) to Career Security (F4) is not statistically significant ($\beta = 0.03$), indicating a limited direct effect. Taken together, Figure 2 shows a structure in which autonomy is primarily shaped by direct exposure to algorithmic systems and AI-supported development, while career-related perceptions play a marginal role in explaining perceived autonomy.

The structural model results are presented in Table 6. The findings indicate that algorithmic control exerts a statistically significant negative effect on perceived autonomy ($\beta = -0.388$, $p < 0.001$), supporting H1. This result suggests that higher levels of algorithmic

control are associated with reduced perceptions of autonomy among employees. In contrast, AI-supported skill development demonstrates a strong and statistically significant positive effect on perceived autonomy ($\beta = 0.43$, $p < 0.001$), confirming H2. This indicates that AI-enabled learning and feedback mechanisms contribute to enhanced perceptions of autonomy in the workplace.

Table 6. Structural Model Results.

Hypothesis	Path	β (Standardized)	SE	C.R.	p -Value	Supported
H1	Algorithmic Control $\rightarrow$ Perceived Autonomy	−0.39	0.033	−8.111	***	Yes
H2	AI-Supported Skill Development $\rightarrow$ Perceived Autonomy	0.43	0.036	8.807	***	Yes
H3	AI-Supported Skill Development $\rightarrow$ Career Security	0.54	0.031	8.170	***	Yes
H4	Perceived Autonomy $\rightarrow$ Career Security	0.03	0.036	0.558	0.577	No

Note: β = standardized coefficient; SE = standard error; C.R. = critical ratio; *** $p < 0.001$.

AI-supported skill development also shows a substantial positive effect on career security ($\beta = 0.54$, $p < 0.001$), supporting H3. This finding suggests that employees who perceive AI as a developmental resource report higher levels of confidence in their professional future. However, the relationship between perceived autonomy and career security is not statistically significant ($\beta = 0.03$, $p = 0.577$), leading to the rejection of H4. This indicates that perceived autonomy does not directly translate into stronger perceptions of career security within the examined context.

The mediation effects are reported in Table 7. The results indicate that perceived autonomy does not mediate the relationship between algorithmic control and career security. Both the direct effect ($\beta = -0.012$) and the indirect effect ($\beta = -0.012$) are not statistically significant, and the 95% bias-corrected confidence interval includes zero (−0.050 to 0.026). Therefore, H5 is not supported, indicating the absence of a mediation effect. Similarly, perceived autonomy does not mediate the relationship between AI-supported skill development and career security. Although the direct effect remains strong and statistically significant ($\beta = 0.54$), the indirect effect via perceived autonomy is small and not statistically significant ($\beta = 0.013$), with the confidence interval crossing zero (−0.028 to 0.058). Thus, H6 is not supported, and no mediation effect is observed. These findings indicate that perceived autonomy did not mediate the relationships between algorithmic control or AI-supported skill development and career security in the present sample.

Table 7. Mediation Effects (Standardized).

Hypothesis	Path	Direct Effect	Indirect Effect	95% BC CI Lower	95% BC CI Upper	Mediation Type	Supported
H5	F1 $\rightarrow$ F3 $\rightarrow$ F4	−0.012	−0.012	−0.050	0.026	No mediation	No
H6	F2 $\rightarrow$ F3 $\rightarrow$ F4	0.54	0.013	−0.028	0.058	No mediation	No

The explanatory power of the structural model is presented in Table 8. The model accounts for 31.1% of the variance in perceived autonomy ($R^2 = 0.311$), indicating a moderate level of explanatory power, suggesting that additional unobserved factors may play a substantial role. Similarly, 30.2% of the variance in career security is explained by the model ($R^2 = 0.302$), which also falls within the moderate range. These results suggest that the proposed structural relationships provide a meaningful, though not exhaustive, expla-

nation of the endogenous constructs, indicating that additional factors beyond the current model may also contribute to employees' perceptions of autonomy and career security.

Table 8. Explained Variance (R^2).

Endogenous Construct	R^2	Interpretation
Perceived Autonomy (F3)	0.311	Moderate
Career Security (F4)	0.302	Moderate

The moderating role of digital literacy in the relationship between algorithmic control and perceived autonomy was examined, and the results are presented in Table 9. The interaction effect between algorithmic control and digital literacy is not statistically significant ($\beta = -0.069$, $t = -1.542$, $p = 0.124$), indicating that digital literacy does not moderate the relationship between algorithmic control and perceived autonomy. Therefore, H7 is not supported. This finding indicates that no statistically significant moderating effect of digital literacy was observed in the relationship between algorithmic control and perceived autonomy.

Table 9. Moderation Analysis.

Hypothesis	Path	β	t	p	Result
H7	AC $\times$ DL $\rightarrow$ Perceived Autonomy	−0.069	−1.542	0.124	Not supported

The explanatory power of the moderation model is presented in Table 10. The model explains 12.8% of the variance in perceived autonomy ($R^2 = 0.128$), indicating a moderate level of explanatory power. Compared to the structural model (Table 8), this lower R^2 suggests that the inclusion of the interaction term (algorithmic control $\times$ digital literacy) does not substantially improve the model's ability to explain perceived autonomy.

Table 10. Explained Variance (R^2) for the Moderation Model.

Endogenous Construct	R^2	Interpretation
Perceived Autonomy	0.128	Low

5. Discussion

The findings of this study contribute to contemporary debates on algorithmic management by suggesting that AI-enabled management should not be understood exclusively through the lens of surveillance and control. This perspective is particularly relevant in hospitality, where algorithmic management is introduced into work environments in which employee discretion, interpersonal judgment, and contextual flexibility constitute core elements of effective service delivery. Consequently, the organizational implications of AI-enabled management may differ from those expected in more standardized work settings, where task execution is more easily codified and routinized. Instead, the results indicate that different organizational applications of AI are associated with qualitatively different implications for employee autonomy and career security. Consistent with the dual-logic perspective developed in this study, the findings suggest that control-oriented and developmental dimensions of algorithmic management are associated with different patterns of employee outcomes. This contributes to current understanding of AI-enabled work by highlighting algorithmic management as a broader organizational governance system rather than a purely control-oriented mechanism.

5.1. Algorithmic Control and the Erosion of Autonomy

The negative effect of algorithmic control on perceived autonomy, as identified in H1, confirms concerns raised in prior research on algorithmic management, particularly regarding the standardization, opacity, and performance monitoring embedded in AI systems (Kellogg et al., 2020; Meijerink & Bondarouk, 2023). The findings suggest that higher levels of algorithmic control are associated with lower perceived autonomy, limiting employees' perceived discretion and reducing their sense of professional agency. Importantly, this relationship remained statistically significant after accounting for digital literacy. This suggests that the negative association between algorithmic control and perceived autonomy was not moderated by employees' levels of digital literacy. Within labor-intensive hospitality organizations, this effect gains additional significance. Unlike highly standardized service environments, hospitality organizations often rely on employees' capacity to adapt to heterogeneous guest expectations, personalize service encounters, and draw on locally embedded experiential knowledge. Within such contexts, autonomy is not only a psychological need but also a functional requirement for maintaining service quality and authenticity.

The introduction of algorithmic control into these settings may create tensions between standardization and contextual responsiveness. While algorithmic systems aim to optimize performance through uniform procedures and data-driven decision-making, they may reduce opportunities for discretionary judgment that are critical for effective service delivery in rural environments. This interpretation is consistent with the relatively strong negative effect observed in the model ($\beta = -0.39$), suggesting that employees may perceive algorithmic governance as less supportive of the operational requirements of their work. Furthermore, the absence of a significant moderating effect (H7) indicates that this relationship did not vary according to employees' levels of digital literacy. Even employees reporting higher levels of digital literacy did not report significantly different levels of perceived autonomy under algorithmic control.

Taken together, these findings suggest that algorithmic control may have unintended consequences for employees' perceptions of professional autonomy in hospitality organizations, raising important questions about the applicability of algorithmic management models across different service environments.

5.2. AI as a Developmental Resource

In contrast to the restrictive effects of algorithmic control, AI-supported skill development emerges as a strong positive predictor of both perceived autonomy and career security, supporting H2 and H3. These findings indicate that algorithmic control and AI-supported skill development are associated with different aspects of employees' work experiences, particularly perceived autonomy and career security. They are consistent with human capital theory (Brynjolfsson & McAfee, 2014) and contemporary perspectives on digital capability development, suggesting that AI-supported skill development may contribute to employees' perceptions of long-term employability and career progression through learning, feedback, and competence enhancement. The positive relationship with perceived autonomy indicates that AI, when perceived as supportive, may enhance employees' sense of professional control by providing informational and developmental resources that support informed decision-making.

Within hospitality organizations, this effect gains additional significance. Employees in such environments often operate in settings characterized by multifunctional roles, limited formal training structures, and strong reliance on experiential learning. AI-supported systems that provide real-time feedback, personalized guidance, and skill enhancement opportunities may therefore compensate for structural limitations in training and career

development pathways. This can strengthen both immediate task-related confidence and longer-term perceptions of professional stability. The strong direct effect on career security suggests that perceptions of career security are more strongly associated with AI-supported skill development than with perceived autonomy in the present model. These findings suggest that immediate workplace experiences and longer-term career evaluations may be influenced by different aspects of AI-related practices, with AI-supported skill development showing a particularly strong association with career security.

Beyond these individual relationships, the findings suggest that effective algorithmic management may require balancing control-oriented functions with AI-supported capability development. While algorithmic monitoring may contribute to operational consistency and efficiency, relying predominantly on surveillance-oriented mechanisms may reduce employees' perceptions of autonomy. Integrating developmental AI functions alongside control mechanisms may therefore enable organizations to achieve operational objectives while simultaneously supporting employee learning, adaptability, and longer-term career development.

5.3. The Limited Mediating Role of Perceived Autonomy

One of the main findings of this study is the absence of significant mediation effects, leading to the rejection of H5 and H6. Despite being influenced by both algorithmic control and AI-supported skill development, perceived autonomy did not translate into increased career security. This finding suggests that, in the present context, perceived autonomy did not function as the primary mediating mechanism proposed by self-determination theory (Ryan & Deci, 2000). Instead, the results leave open the possibility that other psychological and organizational mechanisms, such as organizational trust, perceived fairness, or perceived organizational support, may play a more prominent role in linking AI-enabled management with broader career evaluations. In the present context, perceived autonomy was not significantly associated with career security, suggesting that immediate work experiences and career evaluations may not necessarily be closely related. This pattern may be particularly relevant in labor-intensive service organizations, where career evaluations may depend more strongly on employability, skill relevance, and adaptability to technological change than on immediate work experiences.

The results suggest that career security was more strongly associated with AI-supported skill development than with perceived autonomy. These findings may indicate that, in the present context, perceived autonomy primarily reflects employees' immediate work experiences, whereas career security may reflect broader evaluations of future professional prospects. Alternative explanations should also be acknowledged. The absence of a significant relationship between perceived autonomy and career security may reflect contextual characteristics of the Bavarian hospitality sector, labour-market expectations, measurement limitations, or other unobserved mechanisms that were beyond the scope of the present study. Consequently, these findings should be interpreted cautiously and require validation in other organizational and institutional contexts.

5.4. No Moderating Role of Digital Literacy

The absence of a significant moderating effect of digital literacy, leading to the rejection of H7, suggests that the relationship between algorithmic control and perceived autonomy did not vary according to employees' levels of digital literacy. Contrary to expectations derived from technology acceptance and competence-based frameworks, higher levels of digital literacy did not mitigate the negative association between algorithmic control and perceived autonomy. Employees in such environments often develop practical, experience-based forms of competence that enable them to navigate both technological tools and service

interactions effectively. However, the standardized nature of algorithmic systems may have limited the extent to which these competencies influenced employees' perceptions of autonomy. As a result, digital literacy did not moderate the relationship between algorithmic control and perceived autonomy in the present study.

5.5. Theoretical Contributions

This study found that perceived autonomy did not mediate the relationships between AI-related workplace conditions and career security in the present context. Rather than positioning autonomy as the sole pathway through which algorithmic management influences employee outcomes, the results indicate that its mediating role may be more context-dependent than commonly assumed. They further point to a distinction between experiential constructs, such as autonomy, and future-oriented evaluative constructs, such as career security, suggesting that these dimensions may reflect different aspects of employees' experiences in AI-mediated work environments. The findings also reinforce the importance of distinguishing between the control-oriented and developmental dimensions of AI, which were associated with different employee outcomes. Together, these results contribute to a more nuanced understanding of algorithmic management by suggesting that its organizational effects may vary according to the specific function AI performs within the workplace.

An important implication of these findings is that the organizational consequences of algorithmic management are unlikely to be universal. Greater transparency of algorithmic decision-making, employee participation in AI implementation, supportive leadership practices, and organizational cultures emphasizing learning rather than surveillance may weaken the negative association between algorithmic control and perceived autonomy. Conversely, highly standardized operational environments may reinforce the control-oriented effects of algorithmic management. This indicates that the effects of AI depend not only on the technology itself but also on the organizational context in which it is implemented.

This study contributes to the literature on algorithmic management by highlighting that control-oriented and developmental applications of AI are associated with employee outcomes in different ways, underscoring the importance of examining these dimensions separately. These findings also have broader implications for the design of future AI-enabled workplaces. Rather than treating AI primarily as a mechanism for monitoring employee performance, organizations may benefit from designing algorithmic management systems that combine operational efficiency with employee capability development. Preserving opportunities for discretionary judgment while using AI to support learning, decision-making, and continuous skill development may enable organizations to capture the benefits of digital transformation without undermining the human capabilities on which high-quality service delivery depends.

5.6. Practical Implications for Comparable Rural Hospitality Contexts

The findings suggest that organizations should carefully differentiate between the control and developmental functions of AI systems. While performance monitoring and standardization may enhance efficiency, they may also reduce employees' perceptions of autonomy. At the same time, investment in AI-supported learning and skill development appears important for strengthening perceptions of career security. Importantly, improving employees' digital literacy alone is unlikely to mitigate the negative effects of algorithmic control. Instead, organizations should focus on increasing transparency, flexibility, and human oversight within AI systems to preserve a sense of autonomy. Beyond the Bavarian context, these findings may provide useful insights for hospitality organizations and other

labor-intensive service sectors that share comparable organizational characteristics and are undergoing digital transformation.

Some rural hospitality destinations share organizational characteristics such as the predominance of small and medium-sized enterprises, limited formal HR systems, strong reliance on experiential knowledge, and increasing pressure to adopt digital technologies for competitiveness and visibility. Although these similarities do not imply identical organizational dynamics, they may give rise to comparable challenges when algorithmic management systems—often developed for large-scale, standardized operations—are introduced into labor-intensive service environments. The use of rigid, data-driven control mechanisms may reduce employees' perceptions of autonomy and may affect service delivery in contexts that rely heavily on flexibility and interpersonal judgment.

At the same time, the positive role of AI-supported skill development highlights an important pathway for workforce development. In rural hospitality contexts that share some organizational characteristics with the present study, including regions such as Serbia, where access to continuous professional training may be uneven and institutional support structures less developed, AI-driven learning tools may represent a scalable mechanism for enhancing human capital. However, differences in labour-market institutions, ownership structures, digital infrastructure, and tourism systems should be taken into account when considering the transferability of these findings. By enabling employees to acquire new competencies, adapt to evolving service standards, and engage with digital platforms, such systems may support individual career development while contributing to long-term organizational adaptability and workforce resilience.

These results further indicate that policy approaches focused solely on digital upskilling may be insufficient. While digital literacy remains important, the findings suggest that improving digital literacy alone may not be sufficient to address the challenges associated with algorithmic management. For rural regions, this implies that digital transformation strategies should move beyond capability development and incorporate institutional and organizational design considerations, including transparency of algorithms, participatory implementation, and the preservation of discretionary space for employees.

More broadly, the results indicate that successful digital transformation in rural hospitality requires a context-sensitive approach, in which technological systems are adapted to local service contexts rather than implemented through uniform approaches. This perspective may be particularly relevant for emerging and transitioning tourism destinations in Southeast Europe that face similar organizational challenges, although the applicability of the findings should be evaluated in light of local institutional and operational conditions. Taken together, these findings suggest that effective algorithmic management may require balancing control-oriented functions with AI-supported capability development. While algorithmic monitoring may contribute to operational consistency and efficiency, relying predominantly on surveillance-oriented mechanisms may reduce employees' perceptions of autonomy. Integrating developmental AI functions alongside control mechanisms may therefore enable organizations to achieve operational objectives while simultaneously supporting employee learning, adaptability, and longer-term career development.

6. Conclusions

This study examines how algorithmic management shapes employee experiences in hospitality organizations by integrating control-oriented and capability-enhancing dimensions of artificial intelligence. The results suggest that these dimensions are associated with different employee outcomes. Algorithmic control was negatively associated with perceived autonomy in service delivery contexts. In contrast, AI-supported skill development was positively associated with both perceived autonomy and career security.

The findings indicate that perceived autonomy did not mediate the relationship between workplace conditions and career security in the present context, suggesting that autonomy should be understood as one important psychological mechanism rather than the only pathway through which algorithmic management influences employee outcomes. The absence of a significant moderating effect of digital literacy suggests that differences in digital literacy did not alter the relationship between algorithmic control and perceived autonomy in the present context. Taken together, the findings highlight the importance of examining the control-oriented and developmental dimensions of algorithmic management separately, as they show different patterns of association with employee outcomes. These findings contribute to the literature on algorithmic management by suggesting that control-oriented and developmental dimensions of AI should be examined separately when investigating employee outcomes, as they may operate through different organizational mechanisms.

This study is subject to several limitations that should be considered when interpreting the findings. First, the cross-sectional design does not allow for causal inference, and the observed relationships should therefore be understood as statistical associations rather than causal effects. Second, the empirical context is limited to hospitality organizations in Bavaria, which may constrain the generalizability of the results to other geographical regions or service environments with different structural characteristics. Third, the exploratory and confirmatory factor analyses were conducted using the same dataset. Although this approach is common in organizational research and the measurement model demonstrated satisfactory reliability and validity, future studies should validate the proposed measurement structure using independent samples to further examine its generalizability.

Fourth, the study relies on self-reported measures, which may be influenced by perceptual bias despite the procedural steps taken to minimize common method variance. In addition, the model focuses on perceived autonomy as the principal psychological mechanism and therefore does not examine other potentially relevant mechanisms, such as organizational trust, perceived fairness, psychological safety, or perceived organizational support. Finally, the study conceptualized algorithmic management as a broad organizational phenomenon and did not distinguish between specific categories of AI-enabled technologies (e.g., scheduling systems, performance monitoring tools, decision-support applications, or digital learning platforms). Future research should examine whether different technological applications produce different patterns of employee outcomes.

Future research should address these limitations by employing longitudinal or experimental designs to examine the temporal dynamics and potential causal pathways of algorithmic management effects. Comparative studies across different organizational contexts, including hospitality, platform-based, and other service environments, would further clarify the extent to which the observed relationships are context-dependent. In addition, future research could examine complementary psychological mechanisms, including organizational trust, perceived fairness, psychological safety, perceived organizational support, and technological anxiety, alongside perceived autonomy. Further research may also explore additional contextual moderators, such as organizational culture, leadership style, or algorithmic transparency, to better understand the conditions under which algorithmic systems constrain or enable employee outcomes.

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Appendix A. Initial Measurement Items and Item Retention

Item ID	Measurement Item	Code	Status After EFA
V1	AI systems in the hotel continuously monitor my work performance.	Work monitoring	Retained
V2	Decisions about my work are made based on algorithmic analyses.	Algorithmic decision-making	Retained
V3	I do not have a clear understanding of the criteria by which AI evaluates my performance.	Opaque criteria	Retained
V4	AI systems limit my discretion when interacting with guests.	Reduced discretion	Retained
V5	Algorithmic recommendations carry more weight than the opinion of my immediate manager.	Algorithm priority	Retained
V6	I feel that AI systems determine the pace of my work.	Work pace	Retained
V7	My performance is primarily evaluated through digital indicators.	Digital evaluation	Retained
V8	I have the freedom to adapt my work approach to specific situations with guests.	Operational autonomy	Retained
V9	I can make decisions independently without relying on AI recommendations.	Independent decision-making	Retained
V10	I feel a sense of professional control over my work tasks.	Professional control	Retained
V11	Algorithmic systems do not limit the flexibility of my work.	Work flexibility	Retained
V12	AI serves as support rather than a replacement for my professional judgment.	AI support	Retained
V13	I can deviate from AI recommendations when I consider it necessary.	Discretionary authority	Retained
V14	I feel that my experience is valued despite the presence of AI systems.	Recognition of experience	Retained
V15	AI tools help me improve my professional skills.	Skill development	Retained
V16	I receive personalized feedback through AI systems.	Personalized feedback	Retained
V17	AI enables me to learn new procedures more quickly.	Faster learning	Retained
V18	Algorithmic systems identify areas in which I can improve.	Potential identification	Retained
V19	Thanks to AI support, I feel more competent in my work.	Competence enhancement	Retained
V20	AI systems help me better understand service quality standards.	Quality standards	Retained
V21	AI contributes to my long-term professional development.	Long-term development	Retained
V22	I feel secure about my professional future in the hospitality industry.	Career security	Retained

Item ID	Measurement Item	Code	Status After EFA
V23	I clearly see opportunities for advancement within the organization.	Career advancement path	Retained
V24	I believe my skills are competitive in the labor market.	Market competitiveness	Retained
V25	AI technologies increase my employability.	Technological employability	Retained
V26	I am confident that I can progress professionally in the coming years.	Future advancement	Retained
V27	I feel that my career development is moving in a positive direction.	Positive development	Removed
V28	I have confidence in my professional stability.	Professional stability	Retained
V29	I plan to remain in this organization for the next few years.	Intention to stay	Removed
V30	I feel a strong sense of belonging to the organization.	Organizational belonging	Removed
V31	I am willing to contribute to the long-term development of the hotel.	Long-term commitment	Removed
V32	I would find it difficult to leave this organization even if I had an alternative offer.	Resistance to leaving	Removed
V33	I would recommend this organization as a desirable employer.	Employer recommendation	Removed
V34	I feel emotionally attached to the organization.	Emotional attachment	Removed
V35	I see my future within this organization.	Organizational future	Removed

Note. The initial questionnaire consisted of 35 measurement items. Following exploratory factor analysis, items with insufficient psychometric performance were excluded prior to confirmatory factor analysis and structural equation modeling. The final measurement model comprised 27 retained items.

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