

Revisiting Talent Management and Retention of Engineers in the Era of Digital Transformation and AI: Insights from Malaysia's Electrical & Electronics Manufacturing Sector

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ABSTRACT

Digital transformation and artificial intelligence (AI) are redefining how organizations attract, develop, and retain talent, challenging the traditional foundations of human resource management (HRM). In Malaysia's Electrical and Electronics (E&E) manufacturing sector, a key engine of export and innovation, engineers are vital to competitiveness, yet their retention has become increasingly difficult amid automation, evolving skill demands, and growing concerns over AI's ethical use. This conceptual study revisits talent management and engineer retention through an integrated multitheoretical lens combining the Resource-Based View (RBV), Dynamic Capabilities Theory (DCT), and Human-Centric Artificial Intelligence (HCAI). It advances a Human-AI Synergy Framework that links AI-driven Talent Management Practices (AITMP), such as recruitment analytics, adaptive learning, predictive retention, and data-informed performance management, to Employer Branding (EB) as a mediating mechanism that enhances engineers' Intention to Stay (ITS). The relationship is moderated by HCAI principles of fairness, transparency, explainability, and privacy, and enabled by Dynamic HR Capabilities (DHC) that allow organizations to sense, seize, and reconfigure talent systems in response to digital change. Practically, the study offers actionable insights for Malaysia's E&E companies, including skills personalization, ethical AI governance, augmented leadership, and the infusion of "technological empathy" into employer branding. Conceptually, it positions AI-enabled HRM as both a strategic asset and a moral commitment to human dignity and sustainable retention. The paper concludes with a structured agenda for empirical validation through PLS-SEM mediation and moderation analysis, longitudinal transformation studies, and cross-ASEAN comparative research on AI trust, ethics, and workforce engagement.

Keywords – Talent management; Engineer retention; Artificial intelligence; Human-Centric AI (HCAI); Dynamic capabilities; Employer branding; Digital transformation; Malaysia E&E sector

INTRODUCTION

Introduction

The rapid advancement of digital technologies and artificial intelligence (AI) is transforming the foundations of organizational strategy and human resource management (HRM) worldwide. Nowhere is this transformation more consequential than in Malaysia's Electrical and Electronics (E&E) manufacturing sector, the nation's largest export contributor and a critical pillar of industrial innovation. Within this sector, engineers serve as the intellectual core of innovation, bridging technical design, production efficiency, and problem-solving capabilities that sustain Malaysia's participation in global value chains (Soon et al., 2025; Ahmad et al., 2022).

However, the same technological acceleration that fuels competitiveness also disrupts traditional employment structures. The E&E sector faces an acute paradox: while automation and AI enhance precision, they simultaneously generate talent shortages, low retention, and widening digital-skills gaps (Arora et al., 2024;

Farinha & Pina, 2025; Fareri et al., 2023). Engineers are now required to integrate technical mastery with digital fluency, creativity, and adaptive intelligence, positioning them as both innovators and continuous learners in a rapidly evolving ecosystem.

The Fourth Industrial Revolution (Industry 4.0) has redefined HRM practices through digital transformation. AI-enabled technologies such as predictive analytics, machine learning, and generative AI empower HR professionals to identify turnover risks, personalize development, and enhance engagement (Aguinis et al., 2024; Hung et al., 2025). These systems promise strategic precision and operational efficiency, allowing HR to move beyond administrative functions. Yet, they also introduce ethical, psychological, and cultural dilemmas, ranging from algorithmic bias and data privacy concerns to employee distrust in automated decisions (Fenwick et al., 2024; Kanellopoulou et al., 2025).

Within this complex landscape, Malaysia's E&E companies must strike a delicate balance by leveraging AI for performance optimization while preserving the human values essential for creativity, collaboration, and retention. Engineers' tacit knowledge of grounded in experience, judgment, and contextual understanding remains a unique competitive asset that technology alone cannot replicate (Ahmed et al., 2024). Therefore, retaining this human capital requires not only competitive rewards and digital learning pathways but also ethical, inclusive, and human-centric work cultures that sustain trust and engagement (Zheng, 2025).

Globally, similar challenges have emerged across advanced manufacturing ecosystems. Studies indicate that as organizations pursue digital transformation, they must concurrently cultivate digital leadership, reskilling programs, and psychological safety to ensure that AI adoption enhances rather than erodes workforce morale (Musarat et al., 2024; Kadirov et al., 2024). For Malaysia, which aspires to achieve the Industry4WRD maturity, the readiness of HRM systems is not merely technology infrastructure but will determine whether digital transformation leads to sustainable innovation or workforce fragmentation (Murugiah, 2024; Zulhasni et al., 2020).

Moreover, Malaysia's commitment to the Fourth Industrial Revolution is formally articulated through the National Policy on Industry 4.0—Industry4WRD, launched by the Ministry of International Trade and Industry (MITI) in 2018. The policy serves as a strategic roadmap to transform Malaysia's manufacturing and manufacturing-related services into smart, systematic, and resilient ecosystems powered by advanced technologies such as the Internet of Things (IoT), robotics, big data analytics, and artificial intelligence. Importantly, Industry4WRD highlights that the success of digital transformation hinges not only on technological adoption but also on the "People" dimension, developing digitally competent, agile, and ethically guided workforces. Within this framework, the readiness of HRM systems becomes a decisive factor in ensuring that technological advancement translates into sustainable innovation rather than workforce displacement or fragmentation (Murugiah, 2024; Zulhasni et al., 2020).

Therefore, this is a conceptual study in nature, designed to establish a theoretical foundation for understanding how AI-driven talent management practices influence engineer retention through employer branding and ethical AI governance. While empirical testing is beyond this study's current scope, the model provides a structured basis for future quantitative and qualitative validation across Malaysia's E&E sector.

Problem Statement

Despite the rapid proliferation of AI-enabled HRM practices, there remains a limited contextual understanding of how these technological innovations influence engineer retention in emerging economies. In Malaysia's E&E manufacturing sector, companies have embraced digital transformation with ambition and urgency, yet many continue to grapple with persistent challenges that undermine their ability to retain engineering talent effectively.

One major challenge lies in talent acquisition and retention pressures. While AI-assisted recruitment systems enhance candidate screening and selection efficiency, they often fall short of capturing deeper attributes such as cultural fit, intrinsic motivation, and long-term commitment. As a result, many skilled engineers move toward multinational corporations that offer advanced digital ecosystems and clearer career paths (Tariq, 2024;

Farinha & Pina, 2025). The absence of human predictive, analytics-driven retention mechanisms further increases turnover risks, leaving local companies vulnerable to brain drain.

The continuous pressing issue is the gap in skill development and digital competence. Continuous upskilling is no longer optional in an era defined by automation, data analytics, and AI integration. Yet, many Malaysian manufacturers still lack the digital maturity required to embed AI-driven learning systems into their organization. This misalignment between technological adoption and human capability readiness creates a underlying imbalance, where technology evolves faster than the people expected to operate it (Siddiqui, 2025; Chandratreya, 2025; Fareri et al., 2023).

The transmission of AI in HRM practices also introduces critical ethical and human-centric concerns. Issues such as data privacy, algorithmic bias, and the complexity of decision-making systems challenge the trust that employees place in technology-mediated processes. Engineers, who typically value autonomy, fairness, and meritocracy, may perceive AI-based evaluations as intrusive or unjust if ethical principles are not embedded in their design (Arora et al., 2024; Fenwick et al., 2024; Hung et al., 2025). Consequently, without human-centric safeguards, AI adoption risks alienating the actual workforce it intends to empower.

Beyond technology, cultural and organizational dynamics also shape the effectiveness of digital transformation. Successful AI integration demands more than investment in infrastructure, it requires cultural agility, leadership commitment, and openness to change. However, hierarchical decision-making and limited digital literacy in many Malaysian companies often hinder AI integration, fostering employee resistance and perceptions of job insecurity (Ahmed et al., 2024; Al-Mughairi, 2025; Kanellopoulou et al., 2025). In such environments, digital tools may unintentionally strengthen rather than eliminate traditional barriers to innovation.

Finally, the retention of Generation Z engineers presents an emerging and complex dimension of this challenge. Unlike previous generations, Gen Z professionals prioritize flexibility, meaningful work, and digital empowerment over traditional indicators of job security. Retention strategies that rely solely on financial incentives are increasingly inadequate. Instead, organizations must design holistic engagement strategies that align with Gen Z's expectations for work-life purpose, growth, and technological fluency (Rahman et al., 2025).

Collectively, these interrelated challenges highlight a fundamental contradiction. While AI promises efficiency and accuracy, its organizational success ultimately depends on human acceptance, trust, and ethical alignment. For Malaysia's E&E manufacturing sector, sustainable transformation will hinge on building human-centric digital ecosystems, systems that empower engineers, uphold ethical integrity, and foster continuous learning as the foundation of long-term retention and innovation.

Purpose and Contribution of the Study

This conceptual study aims to revisit and reconceptualize talent management and engineer retention in the era of digital transformation and AI, focusing on Malaysia's E&E manufacturing sector as an empirical and theoretical context. The study seeks to:

1. Examine the interplay between AI-driven talent management practices, employer branding, and engineers' intention to stay.
2. Contextualize global developments (Aguinis et al., 2024; Kanellopoulou et al., 2025) within Malaysia's digitalization agenda, workforce localization policies, and cultural dimensions.
3. Integrate the Resource-Based View (RBV), Dynamic Capabilities Theory (DCT), and Human-Centric AI (HCAI) frameworks to advance HRM theory and offer a humanized model of AI-enabled retention.

By bridging these perspectives, this study contributes to both academic research and practice. It reframes AI from a tool of automation to a catalyst for empowerment, illustrating how organizations can align technological innovation with ethical leadership, inclusivity, and sustainable human development. This

approach positions AI-enabled HRM not only as a source of operational advantage but as a cornerstone of Malaysia's human capital resilience in the digital age.

LITERATURE REVIEW

The Evolving Landscape of Talent Management in the AI Era

The convergence of digital transformation and AI has fundamentally redefined the scope of talent management (Jogarao, 2024). Once centred on administrative efficiency, HRM now operates as a strategic, data-driven discipline that integrates automation, predictive analytics, and algorithmic decision-making (Tariq, 2024; Farinha & Pina, 2025). AI-enabled applications, ranging from recruitment algorithms to turnover-prediction models allow organizations to anticipate workforce needs, identify emerging skill gaps, and design personalized learning experiences (Kadirov et al., 2024; Fareri et al., 2023).

Recent research emphasizes that AI has become an embedded infrastructure within HR decision-making rather than a peripheral device. Aguinis et al. (2024) describe AI as a transformative mechanism that enhances objectivity, reduces bias, and enables real-time workforce planning. Hung et al. (2025) further argue that AI fosters a new form of hybrid intelligence, in which human judgment and machine accuracy co-create strategic value. In Malaysia's E&E sector, this convergence offers both promise and contradiction. While AI increases operational efficiency, it can also depersonalize HR interactions, eroding the trust and psychological safety necessary for long-term engagement (Ahmad et al., 2022; Fenwick et al., 2024). Hence, researchers advocate for human-centric integration, ensuring technology complements rather than replaces empathy and ethical judgment (Chandratreya, 2025; Arora et al., 2024).

Factors Influencing Talent Management and Retention

Career Development and Employee Engagement

Career development remains a key factor in engineer retention. Employees are more likely to stay when organizations provide structured career paths, continuous learning, and recognition (Soon et al., 2025; Alias et al., 2017). AI now supports these processes by mapping evolving skill requirements and aligning employees with future-oriented roles (Farinha & Pina, 2025).

Employee engagement is defined by vigour, dedication, and absorption, and it also predicts retention and performance (Akter et al., 2022). AI-driven sentiment analysis tools can monitor engagement in real time and trigger interventions to prevent burnout (Chao, 2025). Nevertheless, over-reliance on algorithmic monitoring may overlook deeper emotional and cultural drivers of commitment, especially within Malaysia's collectivist work settings (Soon et al., 2025). Therefore, digital engagement must be complemented by authentic leadership communication and relational support.

Reward Management and Work–Life Balance

Equitable compensation and flexible work arrangements remain central to retention strategies. In Malaysia's technology-intensive sectors, performance-based rewards and recognition systems improve satisfaction and loyalty (Alias et al., 2017; Soon et al., 2025). AI enhances fairness in reward allocation by analyzing performance data objectively. However, without transparency, such systems risk perceptions of observation or bias (Kadirov et al., 2024).

Moreover, the shift toward hybrid and remote work has increased demand for work–life balance and psychological well-being. AI-enabled workload-balancing and scheduling tools can reduce fatigue, but their success depends on a culture that values empathy and inclusion (Arora et al., 2024; Chandratreya, 2025). Humanized leadership is therefore vital to sustain morale in digitally mediated workplaces.

Organizational Culture and Change Management

The success of AI-enabled HRM hinges on organizational culture. Cultures that promote trust, experimentation, and continuous learning facilitate smoother technological adoption and mitigate resistance (Ahmed et al., 2024). Many Malaysian companies, however, retain hierarchical structures that impede open communication and innovation (Ahmad et al., 2022).

Effective change management thus requires leadership capable of articulating a shared digital vision and providing psychological safety during transitions (Zheng, 2025; Fenwick et al., 2024). Soon et al. (2025) affirmed that, based on Herzberg's Two-Factor Theory, intrinsic motivators such as recognition, autonomy, and growth opportunities are pivotal for sustaining engagement throughout continual transformation.

Digital Competence and Leadership

Digital competencies form the bridge between technological innovation and workforce agility. Engineers equipped with skills in data analytics, automation, and AI integration underpin Malaysia's industrial competitiveness (Salamzadeh et al., 2025; Siddiqui, 2025).

However, technology adoption alone is insufficient without digital leadership. Leaders who combine technical literacy with ethical intuition and empathy. Such leaders translate complex digital agendas into inclusive organizational narratives, reinforcing trust and adaptability (Musarat et al., 2024; Yen et al., 2024). In Malaysia, leadership development programs integrating AI awareness and ethical principles remain scarce (Ahmed et al., 2024). Strengthening this capability is therefore a national priority for sustainable digital transformation.

Barriers to AI Implementation in Talent Management

Despite its potential, AI adoption in HRM is constrained by skills shortages, limited expertise, and cultural resistance (Ahmad et al., 2022). Many organizations lack HR professionals trained in AI system design and governance. Thus, this skills gap is combined by insufficient national frameworks for digital talent development and weak collaboration between industry and academia (Fahmy et al., 2022).

In addition, ethical barriers also persist, in which employees may distrust AI systems perceived as unclear or invasive, especially when linked to performance appraisal or observation (Fenwick et al., 2024; Hung et al., 2025). Building algorithmic transparency, fairness, and explainability into HR systems is therefore essential to gaining employee buy-in. Without ethical legitimacy, even technologically advanced HRM systems risk failure.

Strategies for Effective Talent Management in the AI Era

Emerging literature underscores that effective talent management in the AI era requires a holistic and human-centred approach that integrates technology with empathy. One of the most prominent strategies is AI-driven personalization, which leverages predictive analytics to customize employees' career paths, learning opportunities, and performance feedback. By tailoring development initiatives to individual needs, organizations can enhance motivation, engagement, and retention (Sainger & Irfan, 2025; Fareri et al., 2023). Personalized insights derived from AI not only help identify skills gaps but also guide employees toward meaningful career paths aligned with their aspirations and organizational goals.

Equally important is the human-centric integration of AI, which emphasizes the need to balance automation with empathy and ethical judgment. While technology can improve efficiency and data-driven decision-making, researchers warn that excessive reliance on algorithms may undermine the human essence of leadership and collaboration. To mitigate this, HR practitioners are encouraged to design AI systems that expand, rather than replace, human judgment in ensuring fairness, inclusivity, and trust in HRM practices (Fenwick et al., 2024).

Another critical pillar of sustainable talent management is continuous learning and upskilling. Organizations must foster cultures of lifelong learning, where employees are empowered to continuously acquire and refine digital competencies. AI-supported micro-credentialing and adaptive learning platforms offer opportunities for self-paced, skills-based education that keeps employees agile amidst technological disruption (Chandratreya, 2025; Li, 2024). Such systems enable employees to remain future-ready while cultivating a sense of purpose and professional growth.

Lastly, the development of collaborative ecosystems between industry, academia, and government has become essential for bridging the talent gap. These partnerships ensure that educational curricula remain aligned with evolving digital industry needs, facilitating smoother transitions from education to employment (Yusuf et al., 2025). Through joint initiatives such as reskilling programs and industry-academia research collaborations, organizations can develop a resilient workforce capable of navigating complex technological landscapes.

Collectively, these strategies signal a fundamental paradigm shift from managing employees merely as resources to empowering them as strategic partners in digital transformation. By aligning AI's technological potential with human values of trust, fairness, and inclusivity, organizations can create workplaces where innovation thrives alongside compassion and shared purpose.

The Ethical Dimension of AI-Enabled HRM

AI introduces a dual challenge of efficiency and ethics. Issues of algorithmic bias, data privacy, and employee supervision threaten to undermine organizational trust (Hung et al., 2025). Aguinis et al. (2024) advocate for human-centred algorithmic design, emphasizing participatory development processes that include HR professionals and employees. Similarly, Fareri et al. (2023) and Kanellopoulou et al. (2025) call for ethical frameworks anchored in transparency and accountability.

In collectivist cultures such as Malaysia's, fairness and relational harmony are key determinants of engagement (Ahmad et al., 2022). Therefore, organizations must embed ethics and communication into every phase of AI adoption to sustain morale and inclusion.

Research Gaps

The literature review concompanies that AI is reshaping HRM globally but reveals notable contextual and theoretical gaps. First, empirical research in emerging economies remains scarce, with most studies focusing on technological readiness rather than employees' experiences of digital HRM (Ahmad et al., 2022; Ahmed et al., 2024). Second, limited theories or frameworks integrate Resource-Based View (RBV), Dynamic Capabilities Theory (DCT), and Human-Centric AI (HCAI) to explain how AI-driven HR practices influence retention outcomes. Third, existing research models often overlook ethical and cultural dimensions essential for understanding how engineers in Malaysia's E&E sector respond to AI adoption. Consequently, this study advances an integrative, human-centred conceptual model that positions AI-enabled talent management as both a strategic capability and a moral imperative, aimed at sustaining innovation and retaining engineers in the digital era.

Theoretical Foundations and Conceptual Framework

Rationale for a Multitheoretical Lens

Retaining engineers in the era of AI and digital transformation represents a complex socio-technical challenge, one that requires organizations to balance technological sophistication with human sensitivity. Engineers are not merely operators of machines but architects of innovation whose expertise underpins organizational competitiveness. Managing and retaining them in an AI-driven environment thus involves more than adopting digital tools, it requires cultivating distinctive human and digital assets (resources), adapting these assets dynamically (capabilities), and implementing them within ethical and trust-based systems (human-centricity).

To capture this multifaceted reality, the present study integrates four complementary theoretical perspectives: the Resource-Based View (RBV), Human Capital Theory (HCT), Dynamic Capabilities Theory (DCT), and Human-Centric Artificial Intelligence (HCAI). Collectively, these frameworks offer a multidimensional explanation of how organizations can create, sustain, and humanize competitive advantage in the digital age. The RBV and HCT identify what resources matter, the unique blend of human knowledge and digital competencies that drive performance. The DCT explains how companies adapt these resources amid turbulence and technological disruption, emphasizing agility and reconfiguration. Finally, HCAI addresses why ethics and trust are necessary to acceptance and retention, particularly when algorithms increasingly mediate workplace experiences. Together, these theories frame AI-enabled talent management not as a purely technical exercise, but as an evolving social and strategic system grounded in capability, culture, and conscience.

Resource-Based View (RBV): Strategic Assets in a Digital Workplace

The RBV posits that sustainable competitive advantage arises from resources that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). Within Malaysia's E&E manufacturing sector, engineers represent such strategic resources. Their tacit knowledge, design-making, and diagnostic problem-solving capabilities form the intellectual infrastructure of innovation and productivity (Alias et al., 2017; Soon et al., 2025). When these human resources are amplified by AI technologies, through data analytics, knowledge management systems, or predictive HR tools, they become even more effective drivers of organizational value.

However, the RBV also cautions that technology alone does not guarantee sustained advantage. AI systems, while powerful, can be easily replicated by competitors. The true differentiation lies in the human capacity to interpret algorithmic insights contextually, applying them with ethical judgment and creativity (Aguinis et al., 2024; Fenwick et al., 2024; Kanellopoulou et al., 2025). In this sense, human capital acts as the cognitive framework that gives digital data its strategic meaning. The RBV thus reinforces the need for human-AI complementarity, an equilibrium where engineers' cognitive flexibility and judgment amplify the analytical precision of AI systems, turning data into decisions and insights into valuable innovation.

Human Capital Theory (HCT): Investing to Create Value

The HCT extends the RBV by framing knowledge, skills, and abilities as productive assets that yield returns through education, training, and learning investments (Caratozzolo et al., 2024). In the context of digital transformation, the value of human capital increasingly depends on individuals' digital fluency, their ability to work effectively with automation, analytics, and AI-enabled systems (Nadezhina, 2021). For engineers in the E&E sector, this includes mastering new software tools, interpreting machine learning outputs, and collaborating in hybrid digital environments.

AI-enabled learning platforms now serve as catalysts for continuous development, diagnosing skill gaps and curating personalized learning experiences. These technologies transform training from a cost-driven HR activity into a strategic investment that enhances employability, engagement, and retention (Fareri et al., 2023; Farinha & Pina, 2025). When organizations invest in engineers' development, through micro-credentialing, mentoring, or adaptive learning, they not only enhance human capital but also long-term commitment, reinforcing trust and loyalty. In this way, HCT underscores that the sustainability of AI-driven transformation depends as much on developing humans as on adopting technology.

Dynamic Capabilities Theory (DCT): Adapting in Continuous Change

While the RBV and HCT emphasize the development of valuable resources, the DCT highlights the processes by which organizations renew and realign these resources to maintain competitiveness in turbulent environments (Teece, Pisano, & Shuen, 1997). DCT introduces the triad of sensing, seizing, and reconfiguring, which are the ability to identify emerging opportunities, mobilize resources to capture them, and continuously reconfigure structures to sustain agility.

AI fundamentally strengthens these dynamic capabilities. Predictive analytics allows HR leaders to sense shifts in skill demand and attrition patterns, AI-driven recruitment and digital learning platforms help grasp new opportunities for reskilling and role redesign, and agile HR architectures enable companies to reconfigure work processes to align with technological and market changes (Fareri et al., 2023; Kadirov et al., 2024). In Malaysia's E&E companies, such dynamic capabilities are embodied in digitally literate leadership and organizational cultures that encourage learning and experimentation (Ahmed et al., 2024; Musarat et al., 2024; Yen et al., 2024). Through this lens, DCT reframes HR not as an administrative unit but as a strategic enabler of transformation, capable of coordinating both human and technological agility in response to continuous change.

Human-Centric AI (HCAI): Ethics, Trust, and Psychological Safety

The HCAI paradigm completes this theoretical integration by embedding ethical and emotional intelligence within the digital transformation process. HCAI advocates that AI systems must enhance, not diminish human dignity, autonomy, and well-being (Aguinis et al., 2024; Hung et al., 2025). In HRM, this translates into practices that prioritize explainability, fairness, and participatory design. Transparent data use and algorithmic accountability are not just ethical preferences but strategic necessities, as they shape trust, the basis of employee engagement and retention.

In Malaysia's collectivist work culture, where relational harmony and perceived justice strongly influence motivation, embedding HCAI principles becomes even more crucial (Ahmad et al., 2022; Kanellopoulou et al., 2025). Engineers are particularly sensitive to issues of fairness and logic, unclear or biased AI systems can quickly erode confidence and cause disengagement (Fenwick et al., 2024). Thus, HCAI reframes technology not as a mechanical substitute for judgment but as a moral partner in decision-making. When implemented responsibly, it ensures that automation complements empathy, data serves dignity, and digitalization strengthens, not weakens, the social constitution of the workplace.

Table 1 below illustrates how the four frameworks (i.e., RBV, HCT, DCT, and HCAI) underpin the conceptualization of strategic, adaptive, and ethical dimensions of AI-enabled talent management and engineer retention.

Table I Summary of Theoretical Foundations Underpinning the Human–Ai Synergy Framework

Theory	Core Focus	Contribution to Framework
Resource-Based View (RBV)	Valuable, rare, inimitable human and digital assets	Explains how AI-enhanced human capital becomes a source of sustainable competitive advantage
Human Capital Theory (HCT)	Investment in knowledge, skills, and learning	Highlights continuous upskilling and capability development as retention enablers
Dynamic Capabilities Theory (DCT)	Sensing, seizing, and reconfiguring resources	Describes organizational agility in adapting AI to workforce needs
Human-Centric AI (HCAI)	Ethical, transparent, and participatory AI use	Ensures fairness, trust, and psychological safety in AI-enabled HRM

Integrated Conceptual Framework

Synthesizing these perspectives, the study proposes a Human–AI Synergy Framework for Talent Management and Engineer Retention, which connects AI-driven talent management practices (AITMP) to engineers' intention to stay (ITS) through the mediating role of employer branding (EB), moderated by human-centric artificial intelligence (HCAI), and enabled by dynamic HR capabilities (DHC). This integrative model reflects the interplay between technology, human experience, and organizational agility, presenting a holistic blueprint for sustainable engineer retention in Malaysia's E&E sector.

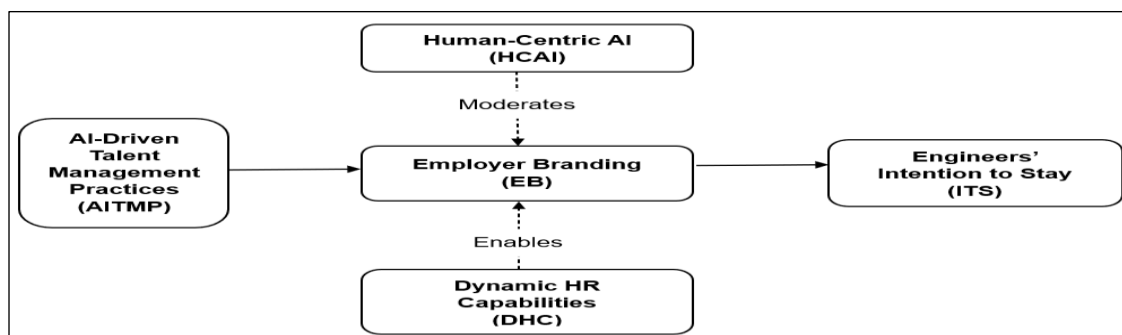
At its foundation, AITMP encompasses recruitment analytics, skills profiling, adaptive learning, predictive retention, and data-informed performance management (Tariq, 2024; Fareri et al., 2023; Farinha & Pina, 2025). These practices strengthen HR's analytical capability while personalizing the employee experience, transforming HRM into a strategic driver of engagement and growth. Simultaneously, EB reflects engineers' collective perceptions of fairness, innovation, career development, and social purpose dimensions increasingly shaped by digital HR interactions (Sainger & Irfan, 2025; Rahman et al., 2025; Kanellopoulou et al., 2025). Ethical and transparent AI integration increases this perception, fostering trust and emotional attachment that strengthen retention.

Engineers' ITS embodies employees' commitment to stay, rooted in perceptions of meaningful work, learning opportunities, and organizational trust (Alias et al., 2017; Soon et al., 2025). When engineers experience AI as a supportive tool that empowers rather than monitors, their sense of belonging deepens. HCAI moderates this process by embedding fairness, transparency, and psychological safety into AI systems, transforming technology into a trusted partner in human development (Aguinis et al., 2024; Hung et al., 2025).

Finally, DHC operate as systemic enablers that allow organizations to sense emerging trends, seize technological opportunities, and reconfigure resources responsively (Teece et al., 1997; Ahmed et al., 2024; Musarat et al., 2024). When HR functions embody both technological literacy and human agility, they foster continuous learning and innovation, ensuring AI adoption enhances, not displaces, the human capabilities in the workplace.

The Human–AI synergy framework (Figure 1) provides an adaptive, relational approach on talent management, integrating digital intelligence with human empathy to foster trust, innovation, and long-term retention in Malaysia's evolving industrial landscape. Furthermore, the conceptual model illustrates how AI-Driven HR Practices increase employer branding, which in turn influences engineers' intention to stay. Human-centric AI moderates these relationships by ensuring fairness, transparency, and trust, while dynamic HR capabilities enable the adaptive transformation of AI integration into humanized HR strategies.

Fig. 1 Human–AI Synergy Framework for Talent Management and Engineer Retention



Propositions

Building on the integrated theoretical framework, several propositions are advanced to explain how AI-driven talent management practices interact with organizational, ethical, and strategic mechanisms to influence engineers' retention in Malaysia's E&E sector. Grounded in the RBV and human capital theory (HCT), it is proposed that AI-driven talent management practices (AITMP) will positively influence employer branding (EB) by signalling the organization's commitment to personalized growth, fairness, and innovation. Predictive analytics, AI-enabled learning, and adaptive HR systems enhance transparency and developmental opportunities, strengthening employees' perception of the firm as a fair and future-ready employer (Fareri et al., 2023; Farinha & Pina, 2025).

P1: AITMP will positively influence EB.

Next, EB is expected to mediate the relationship between AITMP and engineers' ITS by translating technological sophistication into emotional attachment and perceived career value. When AI-based HR tools create consistent, personalized, and trustworthy experiences, engineers are more likely to feel engaged and

aligned with organizational purpose, reinforcing their long-term commitment (Sainger & Irfan, 2025; Rahman et al., 2025).

P2: EB will mediate the relationship between AITMP and engineers' ITS.

Drawing on the HCAI perspective, the positive relationship between AITMP and engineers' ITS is expected to strengthen when HCAI practices, such as fairness, transparency, explainability, and privacy are strongly embedded in HR systems (Aguinis et al., 2024; Hung et al., 2025; Kanellopoulou et al., 2025). Ethical AI design fosters trust and psychological safety, ensuring that engineers view technology as an enabler of empowerment rather than surveillance or bias.

P3: The positive effect of AITMP on ITS will be stronger when HCAI practices (fairness, transparency, explainability, privacy) are high.

Consistent with the DCT, dynamic HR capabilities and the organization's ability to sense, seize, and reconfigure talent strategies are proposed to strengthen the relationship between AITMP, EB, and ITS. Companies with agile HR functions can more effectively align digital initiatives with evolving workforce needs, accelerating skill alignment, role redesign, and innovation-driven retention (Ahmed et al., 2024; Musarat et al., 2024).

P4: Dynamic HR capabilities (sense–seize–reconfigure) will strengthen the relationship between AITMP, EB and ITS.

Despite the optimistic potential of AI in HRM, its misuse or ethical neglect can produce what researchers increasingly call the “dark side” of AI-HRM. When AI systems lack transparency, fairness, or explainability, they can distort decision-making, trigger perceptions of surveillance, and erode trust. In such cases, AI adoption may backfire, weakening EB and diminishing employees' ITS. Engineers, who value autonomy and merit-based recognition, are particularly sensitive to unclear algorithms and data misuse. Therefore, the absence of HCAI principles transforms technology from an enabler into a source of disengagement and attrition. This dynamic underscore the need for ethical safeguards, reinforcing that successful AI-HRM must balance efficiency with empathy, accuracy with privacy, and automation with accountability.

Although the model assumes positive relationships, it is important to acknowledge a potential boundary condition. Without adequate HCAI safeguards, AI-enabled HR practices could inadvertently generate perceptions of surveillance or bias, weaken EB and reduce retention. This cautionary insight does not form a separate proposition but underscores the ethical importance of maintaining transparency, fairness, and trust in all AI-mediated HR processes.

In conclusion, these propositions clarify how AI-driven HRM, when guided by ethics and dynamic capabilities, contributes to sustainable engineer retention. They emphasize that technology alone cannot secure loyalty, only when integrated with human-centred values and strategic agility can AI truly enhance long-term commitment and organizational sustainability.

DISCUSSION

Theoretical Implications

The findings of this conceptual exploration underscore that talent management in the AI era cannot be separated from its human foundation. Across the literature, AI technologies adoption enhances the accuracy of talent analytics, enable personalized learning, and strengthen predictive retention strategies. Yet, their actual value unfolds only when technology adoption enhances rather than replaces human expertise and empathy (Kadirov et al., 2024; Farinha & Pina, 2025; Aguinis et al., 2024; Hung et al., 2025). For Malaysia's E&E sector, where engineers drive continuous innovation and face demanding production cycles, the transition toward AI-enabled HRM must be grounded in a human-centric philosophy that values well-being, transparency, and trust (Fenwick et al., 2024; Soon et al., 2025).

From a theoretical perspective, this study integrates multiple perspectives, Resource-Based View (RBV), Human Capital Theory (HCT), Dynamic Capabilities Theory (DCT), and Human-Centric Artificial Intelligence (HCAI), to present a holistic understanding of AI-driven talent management. RBV and HCT frame human capital as a strategic resource whose value is increased through technology adoption. DCT explains how organizations must sense, seize, and reconfigure these assets to sustain agility amid digital disruption. Meanwhile, HCAI serves as the ethical and psychological foundation that safeguards fairness, participation, and employee dignity (Ahmad et al., 2022; Ahmed et al., 2024; Kanellopoulou et al., 2025).

Equally important, this synthesis recognizes the “dark side” of AI-HRM. In the absence of human-centric safeguards, algorithmic complexity, excessive surveillance, or data misuse can damage psychological safety, erode trust, and weaken the employer–employee relationship. This negative spiral is particularly concerning in knowledge-intensive contexts like engineering, where autonomy, fairness, and technical integrity underpin motivation and innovation. Hence, humanizing AI is not a sentimental aspiration, it is a theoretical imperative that ensures technological progress aligns with ethical governance and sustainable workforce relationships.

Ultimately, the theoretical contribution of this paper lies in reframing AI-enabled talent management as a human–AI partnership system. It highlights that competitive advantage in the digital era is co-created through the synergy of human judgment, ethical responsibility, and technological capability. The integration of RBV, HCT, DCT, and HCAI thus provides a nuanced theoretical lens for understanding how AI can elevate, not endanger, the human dimensions of organizational success.

Practical Implications

Translating this theoretical integration into action requires organizations to operationalize AI systems that are not only intelligent but also empathetic, inclusive, and transparent. The notion of “technological empathy” can be explained by the capacity to deploy AI in ways that understand, respect, and respond to human needs, capturing this balance between analytics and compassion. In practice, Malaysian E&E companies should begin by identifying digital skill gaps and implementing AI-based profiling tools to map current and future competencies. When coupled with adaptive learning systems, mentoring, and cross-functional projects, these initiatives transform training into a trust-based investment, resonating with younger generations’ desire for autonomy, purpose, and career growth opportunities (Fareri et al., 2023; Farinha & Pina, 2025; Siddiqui, 2025; Rahman et al., 2025).

Reward systems must also evolve. While AI can improve objectivity in reward and recognition, perceived fairness still hinges on human transparency and relational appreciation. Managers should make reward criteria visible, use dashboards to showcase contributions, and complement data-driven assessments with genuine recognition from leaders (Kadirov et al., 2024; Akter et al., 2022; Soon et al., 2025). This dual approach ensures that algorithmic precision does not eclipse human judgment, a balance essential for sustaining engagement.

Leadership represents another critical enabler of digital transformation. Cultural change advances only at the pace of trust, thus, leaders who translate complex AI agendas into clear, human narratives foster psychological safety and participation (Musarat et al., 2024; Ahmed et al., 2024). “Augmented leadership,” which combines analytical insight with empathy, should become central to leadership development frameworks (Aguinis et al., 2024; Yen et al., 2024). In addition, strong ethical AI governance is vital. Engineers, often analytical and justice-oriented, scrutinize fairness and transparency closely. Non-transparent systems in hiring, appraisal, or monitoring can provoke AI anxiety and resistance (Hung et al., 2025). Effective governance should therefore include consent mechanisms, bias audits, explainability protocols, and human participatory design processes that institutionalize HCAI principles (Fenwick et al., 2024; Kanellopoulou et al., 2025; Arora et al., 2024).

At the strategic level, organizations must improve employer branding through human-centred innovation narratives. Employer branding acts as a psychological bridge linking AI-enabled HR practices with employee retention. Companies that communicate purpose, growth opportunities, and ethical responsibility position AI as a symbol of empowerment rather than surveillance (Sainger & Irfan, 2025; Rahman et al., 2025; Hung et al., 2025).

For Malaysia's E&E sector, these imperatives translate into several practical steps. AI should be embedded within human-centric HR architectures that emphasize insight over control. Continuous learning must be institutionalized through integrated skills-based programs and industry-linked qualifications (Chandratreya, 2025; Li, 2024). HR practitioners must acquire digital-ethical fluency, supported by toolkits and programs in AI literacy (Arora et al., 2024; Hung et al., 2025). National collaborations through Industry4WRD, MIDA, and HRD Corp should align with firm-level strategies to accelerate ecosystem-wide reskilling (Murugiah, 2024; Zulhasni et al., 2020; Ahmad et al., 2022; Fahmy et al., 2022).

Modernizing HR roles is also critical. New hybrid positions such as ethical AI leads, talent intelligence specialists, and HR analytics translators can drive the integration of human and digital systems (Ahmed et al., 2024; Musarat et al., 2024). In parallel, digital well-being programs must identify workload patterns and promote recovery practices that sustain psychological health (Zheng, 2025; Chao, 2025). Finally, retaining Gen Z engineers requires purpose-driven autonomy, mission-linked projects, internal gig platforms, and flexible career paths that reward both exploration and execution (Rahman et al., 2025; Soon et al., 2025).

In conclusion, the path toward human-centred digital transformation demands that organizations treat technology not as a substitute for human intelligence but as an amplifier of it. Aligning RBV and HCT principles (investing in unique human capital) with DCT (adapting dynamically) and HCAI (ensuring ethical alignment) enables organizations to achieve agility without abandoning the humanity that underpins trust, creativity, and long-term retention.

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

Conclusion

As a conceptual contribution, this study offers a theoretical framework for future empirical research rather than direct statistical validation. Its strength lies in integrating RBV, DCT, and HCAI to illuminate how human-AI collaboration can sustain engineer retention. Future studies should operationalize and test these propositions across diverse industrial contexts.

This conceptual study argues that AI-enabled talent management represents both a technological evolution and a strategic imperative for Malaysia's E&E sector. Artificial intelligence can refine workforce planning, personalize learning, and support proactive retention, but its real value lies in amplifying human capability while preserving ethical integrity (Aguinis et al., 2024; Hung et al., 2025). Integrating the resource-based view (RBV) and human capital theory (HCT) illustrates the significance of unique human skills and AI-augmented HR capabilities as strategic resources. The dynamic capabilities theory (DCT) explains how companies sustain advantage by continuously sensing, seizing, and reconfiguring talent systems as technologies evolve (Ahmed et al., 2024; Musarat et al., 2024; Teece et al., 1997). The human-centric AI (HCAI) paradigm further explains why acceptance and retention sustained due to fairness, transparency, and participation cultivate trust and psychological safety (Fenwick et al., 2024; Kanellopoulou et al., 2025; Arora et al., 2024).

Malaysian companies must regard AI as a driver for human development rather than a replacement. This requires closing digital-skills gaps, institutionalizing ethical AI governance, and expanding continuous learning ecosystems that convert analytics into meaningful career experiences (Fareri et al., 2023; Farinha & Pina, 2025). At a national level, policy support through initiatives such as Industry4WRD and HRD Corp can alleviate persistent barriers, including uneven AI literacy, fragmented governance, and shortages of digitally skilled engineers (Murugiah, 2024; Zulhasni et al., 2020; Ahmad et al., 2022; Fahmy et al., 2022). Ultimately, retaining engineers in the AI era extends beyond compensation, but it depends on designing humane, data-informed work systems where algorithms manage the routine and humans create value, judgment, and purpose (Alias et al., 2017; Soon et al., 2025).

Future Research Directions

Building on this conceptual foundation, future studies should empirically test the proposed human-AI synergy framework through a structured, multi-stage research agenda.

Construct Operationalization: Future empirical work could operationalize AI-driven Talent Management Practices (AITMP) using adapted scales from Tariq (2024), encompassing dimensions such as (i) recruitment analytics, (ii) predictive retention systems, (iii) AI-enabled learning personalization, and (iv) data-informed performance management. Employer Branding (EB) may be measured using dimensions of fairness, career development, innovation, and social purpose (Baratelli & Colleoni, 2022), while Intention to Stay (ITS) can adopt scales validated by Alias et al. (2017) and Soon et al. (2025). Human-Centric AI (HCAI) should include fairness, explainability, privacy, and participatory design (Aguinis et al., 2024), and Dynamic HR Capabilities (DHC) could be adapted from Teece et al. (1997).

Methodological Approach: A quantitative research design using partial least squares structural equation modelling (PLS-SEM) is recommended to test mediation (EB) and moderation (HCAI) effects. A multi-stage, stratified sampling method should be employed to collect data from engineers across multinational and local companies in Malaysia's E&E sector. Control variables such as firm size, organizational age, years of experience, and job level should be incorporated to ensure robustness.

Analytical Extension: Longitudinal designs can further capture DCT's adaptive cycle, tracking how organizations evolve through AI maturity stages from resistance to normalization. Complementary qualitative studies, such as interviews with HR leaders and engineers, can provide deeper insights into ethical perceptions, leadership roles, and cross-generational responses to AI adoption. Comparative analyses across ASEAN economies can reveal cultural contingencies affecting AI trust and retention.

By combining these methodological paths, future research can transform the current conceptual model into an empirically validated framework that guides sustainable, ethical, and human-centred digital transformation.

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