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Abstract

Purpose: This study explores the dynamic interplay between innovative digital technologies and improvisation in advancing Circular Economy (CE) practices through Human Resource Management (HRM) strategies within SMEs.

Design: Conducted within the turbulent environment of SMEs in a developing country, the study draws on insights from a multi wave survey of 384 respondents, evaluating the interrelationships between HRM, improvisation, CE practices, and digital technologies through hierarchical regression analysis.

Findings: We found that the integration of advanced digital technologies with well-structured HRM systems creates an environment that fosters improvisation, enabling SMEs to address the complexities of CE initiatives effectively.

Originality/value: By focusing on the mediating role of improvisation and the contextual influence of digital technologies, this research bridges HRM theory with practical CE advancements. The paper illuminates for both academics and practitioners how digital innovation and improvisation, when aligned with HRM practices, can help SMEs adapt to uncertainty and accelerate progress toward sustainable CE outcomes.

Keywords: Circular economy, Human resources management, Improvisation, Digital technology

Introduction

As sustainability becomes a strategic imperative, small and medium-sized enterprises (SMEs) are increasingly expected to adopt circular economy (CE) principles that prioritize regeneration, resource efficiency, and systemic reuse (Geissdoerfer et al., 2017; Korhonen et al., 2018). However, transitioning toward CE is inherently disruptive—it demands not just technological upgrades or structural adjustments, but deep organizational change involving rethinking how decisions are made, and problems are solved. For SMEs in developing countries, this challenge is exacerbated by institutional gaps, limited resources, and volatile environments (Schroeder et al., 2019; Luo and Qiao, 2024).

While the literature on CE implementation has grown rapidly (Jabbour et al., 2018), it remains dominated by macro and process-oriented approaches, often overlooking the micro foundations of organizational behaviour, particularly human resource management (HRM) systems and their role in enabling or impeding CE transitions (Jabbour et al., 2019). Although research indicates that the circular economy has received considerable attention because of its potential to enhance human development (Erum at al., 2024), as well as its mediation role

between green HRM and organizational resilience (Elshaer, 2024) – which shows a mutual relationship between HRM and CE (Singh. R et al., 2022) - there still exists a gap between human resource practices and the activities particularly concerning the recycling, reuse, and repurposing of materials within various sectors (Sehnem et al., 2025).

Castro Lopez et al. (2025) believe that integrating circular economy values into human resource management (HRM) practices can help facilitate a company's transition to the circular economy. Where HRM has been considered, the focus tends to rest on structural alignment—such as green HRM policies, employee engagement, or environmental performance targets (Haddock-Millar et al., 2016)—rather than on behavioral mechanisms that might foster adaptive responses in dynamic sustainability contexts. This emphasis on structure over agency reveals a theoretical limitation in the CE–HRM nexus.

To address this gap, we introduce organizational improvisation as a core mechanism linking HRM to CE outcomes. Improvisation - defined as the spontaneous and creative recombination of resources in real time under conditions of uncertainty (Hadida et al., 2015)- is increasingly critical in sustainability transitions, particularly where standard operating procedures are insufficient, and novel solutions must be developed on the fly. However, existing CE–HRM models rarely theorize improvisation explicitly. Where adaptability or flexibility is mentioned, it is often conflated with agility or treated as an incidental byproduct of other HR practices, rather than a discrete behavioural capability requiring targeted HRM support.

This leads to our central theoretical puzzle: How can HRM systems—typically designed for stability, control, and institutional conformity—foster the improvisational behavior required for circular economy innovation? Is improvisation merely absent from existing CE–HRM models, or is it mischaracterized as informal, reactive behavior, thereby

underappreciated as a strategic capability? We argue that improvisation is not only underrepresented but also theoretically underdeveloped in this literature. Without clearer conceptualization, we lack insight into how improvisation mediates HRM influences on CE practices and how firms can deliberately cultivate it.

On the other hand, the increasing infusion of digital technologies into HRM and operations adds another layer of complexity. Digital tools have the potential to both structure and liberate organizational behaviour, offering real-time data, communication platforms, and flexible process controls that can amplify or constrain improvisation (Ciuchta et al., 2021). As such, we examine how digital technology moderates the HRM–improvisation–CE pathway.

Therefore, this paper addresses that theoretical gap by (1) positioning improvisation as a mediating construct between HRM systems and CE implementation in SMEs, and (2) introducing digital technology as a boundary condition that may enable or constrain this pathway. We contend that specific HRM configurations—those promoting ability, motivation, learning, and empowerment—can create fertile ground for improvisation. Moreover, the presence of enabling digital technologies (e.g. real-time data access, collaboration tools, decision-support systems) may amplify this improvisational capacity by reducing coordination friction and expanding cognitive reach (Tariq et al., 2025).

By framing the study as a response to a theoretical contradiction—between the institutional logic of HRM systems and the emergent logic of improvisation—we move beyond a descriptive literature gap. We develop and test a conceptual model (Figure 1) in which improvisation plays a central mediating role, linking HRM systems and CE practices, while digital technologies moderate these dynamics. This framing positions the research not simply as context-specific, but as contributing to theory development at the intersection of HRM, sustainability, and organizational behaviour.

Improvisation and digital technologies were selected as focal constructs due to their centrality in enabling firms, especially SMEs, to respond dynamically to the uncertainties embedded in circular economy (CE) transitions. Improvisation, understood as spontaneous and creative action under time and resource constraints, has been linked to organizational adaptability and real-time problem solving, making it especially relevant in the fluid and experimental nature of CE practices (Hadida et al., 2015; Cunha et al., 2015). Rather than being an ad hoc response, improvisation can function as a routinized capability in settings where formal planning is insufficient to navigate systemic change. Within this framework, digital technologies act not only as tools but as transformative infrastructures that alter the possibilities for improvisational behavior. Technologies such as IoT, cloud platforms, and data analytics facilitate continuous information flows and resource recombination, allowing firms to pivot rapidly and experiment with circular strategies (Nambisan et al., 2017). The interaction between digital affordances and improvisational competencies offers a lens through which to examine how SMEs engage in CE initiatives without the structural advantages of large firms. This dynamic interplay remains under-theorized in CE literature and merits closer empirical and conceptual attention. Figure 1 shows the research model.

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Literature Review

Circular Economy and SMEs

The transition to Circular Economy (CE) models has become a strategic priority for firms facing pressures from regulators, customers, and global sustainability imperatives

(Geissdoerfer et al., 2017; Hopkinson et al., 2018; Liu et al, 2024a). CE calls for rethinking resource use, closing material loops, and reconfiguring value creation around regeneration rather than consumption (Korhonen et al., 2018). Small and medium-sized enterprises (SMEs), which comprise over 90% of businesses globally (Maksimov et al., 2017), are increasingly seen as critical actors in this transformation. The positive effects attributed to CE adoption—such as cost savings, innovation, and competitive advantage—are typically underpinned by specific organizational mechanisms, including enhanced collaboration across supply chains, increased resource productivity, and feedback-driven design loops (Ranta et al., 2021; Pieroni et al., 2021). These mechanisms foster capability development by encouraging process innovation and systemic thinking, which in turn strengthen firms' adaptive and learning capacities (Bocken et al., 2016a). Moreover, the reconfiguration of business models around CE principles often facilitates tighter alignment between environmental goals and operational practices, resulting in measurable performance gains over time (Urbinati et al., 2017). Understanding these relational pathways is essential for grasping how CE implementation leads to strategic outcomes in SMEs.

SMEs offer fertile ground for CE experimentation due to their size, adaptability, and entrepreneurial orientation (Elf et al., 2022). However, they also face structural constraints—limited financial capital, skill shortages, and weaker institutional support—that complicate CE adoption (Taymaz & Üçdoğruk, 2009; Sharma et al., 2021). These constraints demand innovative and often non-standard responses, making SMEs a particularly relevant context for understanding adaptive behavioural mechanisms such as improvisation.

Improvisation and Circular Economy

Improvisation—the ability to respond in real time to unstructured problems with novel combinations of available resources—is increasingly recognized as a necessary capability in dynamic and uncertain environments (Hadida et al., 2015; Mardani et al., 2024). In the context of CE, where standard procedures are often inadequate and novel sustainability solutions must emerge quickly, improvisation enables firms to translate ambiguity into actionable responses (Bertassini et al., 2021). Improvisation, as both a cognitive and behavioural capacity, involves real-time sensemaking, spontaneous decision-making, and the fluid adjustment of actions in response to unfolding challenges (Cunha et al., 1999). It is not mere ad-hoc reactivity, but a capability shaped by organizational routines, cultural norms, and HRM practices that promote autonomy, experimentation, and tolerance for ambiguity.

Improvisational behaviour facilitates experimentation, cross-functional learning, and fast adaptation—elements essential for CE success (Vera et al., 2016). In resource-constrained SMEs, it allows teams to creatively recombine what they have rather than wait for ideal conditions. It also supports rapid prototyping and iterative problem-solving—core practices in CE initiatives that rely on local knowledge and emergent insights. However, the literature on CE rarely theorizes how such improvisational behaviour can be intentionally cultivated, especially through HRM systems. Integrating improvisation into CE practice thus requires a shift from viewing it as reactive to framing it as a dynamic, learnable capability central to organizational resilience and environmental innovation.

HRM Systems and Improvisation: The AMO Perspective

Human Resource Management (HRM) is traditionally associated with formalized routines—selection, training, performance appraisal, and reward systems. This raises a conceptual tension: Can structured HRM systems support the spontaneity and reflexivity required for

improvisation? The Ability–Motivation–Opportunity (AMO) framework (Lee et al., 2019) offers a useful lens to answer this question.

According to AMO theory, HRM enhances performance by equipping employees with the skills (ability), incentives (motivation), and supportive environments (opportunity) necessary to perform effectively (Appelbaum et al, 2000). While ability- and motivation-enhancing practices are well established, opportunity-enhancing HRM practices—such as autonomy, participatory decision-making, and cross-functional teamwork—are particularly relevant for enabling improvisation. These practices provide employees with the space, psychological safety, and discretion needed to act spontaneously and creatively in response to unexpected challenges (Lai et al., 2025).

Improvisation does not emerge from chaos; it requires conditions of partial structure and bounded autonomy. Opportunity-enhancing HRM routines establish these conditions by deliberately loosening control mechanisms and encouraging real-time problem-solving. However, this theoretical bridge between HRM and improvisation—particularly via the AMO model—remains underdeveloped and rarely empirically tested, especially in CE contexts.

Theoretical Framing: Choosing AMO over RBV

This study adopts the Resource-Based View (RBV) as the primary theoretical framework to explore the relationship between Human Resource Management (HRM) practices and employee improvisation. The RBV emphasizes the importance of an organization's internal resources and capabilities as critical drivers of competitive advantage. By centring our analysis on RBV, we can better understand how specific HRM practices serve as valuable resources that enhance employee behaviour and lead to improved organizational outcomes.

In this context, effective HRM practices play a vital role in developing and nurturing employee capabilities, ensuring that they possess the necessary skills to navigate complex challenges. Initiatives focused on training and development align with organizational needs and enhance employees' readiness to engage in improvisational behaviour. Moreover, the RBV underscores the significance of organizational culture and structure as vital resources influencing employee actions. HRM practices that promote a culture of trust, collaboration, and open communication create an environment where employees feel empowered to express innovative ideas and engage in improvisation.

Ultimately, by fostering an agile and adaptable workforce, organizations can harness employee improvisation as a strategic resource, enabling firms to respond effectively to changing market conditions and customer needs while maintaining a competitive edge. This single focus on RBV allows for a more coherent and in-depth exploration of how HRM practices can influence employee improvisation, elucidating the mechanisms by which internal resources are leveraged for CE practices. Such a concentrated approach not only clarifies the relevance of RBV to the constructs at hand but also provides actionable implications for practitioners aiming to enhance CE activities through effective HRM strategies.

Conceptual Gap and Research Direction

Despite growing interest in CE adoption and improvisational capability, the integration of improvisation into CE–HRM models remains conceptually weak. Most studies treat improvisation as incidental or reactive, rather than as a deliberate capability shaped by HRM. Furthermore, the mechanisms by which HRM—particularly opportunity-enhancing practices—foster improvisation are poorly specified. This leads to our central research question: How do HRM systems, foster employee improvisation in support of CE

implementation in SMEs? To answer this, we develop a conceptual model grounded in the AMO framework and test it empirically. The model also considers the moderating role of digital technologies, which may amplify or constrain the improvisational potential of HRM systems.

Hypotheses development

HRM System as Driver of Organizational Improvisation

Existing research has highlighted that improvisation is shaped by various contextual factors, including management practices, though the specific role of HRM systems in fostering improvisation has been underexplored (Vera et al., 2016). Management initiatives, particularly those centred on HRM practices, are likely to significantly influence improvisational capabilities (Cunha et al., 2020). In this study, we argue that HRM systems, especially those incorporating the AMO (Ability, Motivation, and Opportunity) framework (Lee et al., 2019; Chuang et al., 2016), serve as a critical driver of organizational improvisation, which would help navigate the complexities of the CE. While traditional human resource management (HRM) primarily focuses on administrative tasks such as recruitment, payroll, compliance, and employee relations, with the overarching aim of maintaining organizational stability and efficiency (Storey, 1992), developed human resource management systems (HRMS) represent a more evolved approach. These HRMS emphasize enabling employees through skill development, motivating them, and creating opportunities for meaningful contributions to organizational goals (Lee et al., 2019).

One of the well-known HRMS is the AMO-based framework, which is one of the most widely applied theoretical perspectives for understanding HRM practices (Chuang et al., 2016;

Appelbaum et al., 2000). In the AMO framework, ability refers to the physiological and cognitive skills required for effective task performance. It encompasses employees' knowledge, skills, competencies, and proficiencies (Kim et al., 2015; Shahzad, 2023). Motivation is described as the driving force that energizes and sustains behaviour, reflecting employees' willingness and desire to undertake tasks (Jiang et al., 2012; Gagné, 2018, Gagné and Deci, 2005; Bos-Nehles et al., 2023; Van Iddekinge et al., 2018). Opportunity refers to external contextual factors that influence and facilitate task performance, including organizational structures and systems that empower employees (Parker et al., 2006; Bos-Nehles et al., 2023). HRMS integrate traditional HR functions with advanced analytics, talent management, and even sustainability strategies, positioning organizations to address dynamic challenges—essential for advancing circular economy (CE) practices. For example, while traditional HRM may focus on fulfilling immediate hiring needs, HRMS guided by the AMO framework can support long-term sustainability by fostering skills such as resource efficiency, eco-design, and cross-functional collaboration. These capabilities are crucial for CE adoption, as they enable organizations to embed sustainable practices into their operations and workforce strategies (Guerci et al., 2016).

Improvisation, as defined by Miner et al. (2001) refers to an organization’s ability to quickly adapt and innovate in response to unforeseen challenges or emerging opportunities. In the context of the CE, where businesses are required to rethink resource management and innovate sustainable solutions, improvisation becomes crucial. Drawing on the Resource-Based View (RBV) of the firm (Wright et al., 2001), we posit that HRM systems cultivate adaptability and flexibility among employees, particularly in SMEs, ensuring these organizations can swiftly respond to the demands of CE. For example, by integrating CE principles into performance appraisals, job roles, and reward systems, organizations can foster a workforce committed to sustainability (Guerci and Carollo, 2016; Collins and Clark, 2003).

This, in turn, supports employees in their pursuit of CE practices, empowering them to engage in eco-friendly initiatives such as recycling, resource optimization, and waste reduction.

The "ability" component of AMO ensures employees have access to the necessary training and development opportunities to build the competencies required for improvisation toward CE-related tasks, such as developing sustainable products or optimizing resource use (Lee et al., 2019). In addition, HRM systems enhance employee "motivation" by recognizing and rewarding sustainability efforts, creating an improvisational culture that encourages innovation and risk-taking in the pursuit of CE objectives (Singh et al., 2020). Organizations that cultivate a motivated workforce focused on environmental sustainability create a VRIN (valuable, rare, inimitable, and non-substitutable) resource (Ly & Ly, 2024). For instance, providing financial incentives or recognition for employees who contribute to waste reduction initiatives or propose innovative recycling methods can stimulate a culture of continuous improvement. Furthermore, HRM systems create "opportunities" for improvisation by fostering collaboration, teamwork, and knowledge-sharing initiatives towards agility, rapid problem-solving and creative responses to CE challenges (Chuang et al., 2016). For example, an SME facing supply chain disruptions due to resource shortages might rely on improvisational problem-solving skills fostered through HR initiatives to identify alternative materials or methods, aligning with CE principles.

Given the increasing importance of CE practices, especially in resource-constrained contexts, the role of HRM systems in promoting improvisation is even more pronounced. HRM systems help SMEs navigate the unpredictability of CE by ensuring employees are not only equipped with the skills and motivation to innovate but also operate in an environment conducive to rapid adaptation. Therefore, building on the AMO model, we propose the following hypothesis:

Hypothesis 1: *An HRM system positively influences improvisation in SMEs.*

Improvisation and Circular Economy

Unlike the traditional linear economy, where resources are extracted, used, and discarded, CE focuses on extending product lifecycles, enhancing resource productivity, and reducing environmental impact (Panchal et al., 2021). However, many organizations struggle with limited access to technological advancements, which are critical for operationalizing CE principles, such as advanced recycling technologies or resource-efficient production systems (Domenech and Bahn-Walkowiak, 2019). Additionally, a cultural shift is required, as consumers and businesses alike need to adopt new ways of thinking about consumption, ownership, and product lifecycles (Hobson and Lynch, 2016). Resource scarcity, supply chain complexities, and the need for collaboration between various sectors (Batista et al., 2018; Lisi et al., 2024) further complicate the CE transition (Lu et al., 2024; Kamoche & Cunha, 2001), particularly in industries heavily reliant on non-renewable resources.

Improvisation, defined as the ability to spontaneously adapt and innovate in response to unforeseen challenges (Vera and Crossan, 2005), plays a crucial role in addressing the specifications and overcoming the challenges of CE. SMEs, with their smaller size and organizational flexibility, are particularly well-positioned to benefit from improvisational approaches when adopting CE. Since CE requires businesses to constantly rethink and optimize resource use, improvisation enables them to swiftly modify processes, redesign products, and explore innovative solutions to resource constraints (Kamoche and Cunha, 2001). For example, in the context of waste reduction, an SME might not have the financial resources to invest in high-tech recycling machinery. However, they can redesign their production processes to minimize waste (Ranjbari et al., 2024) or repurpose by-products into new offerings (Bocken et

al., 2016b) specificality through improvisation. Moreover, when facing resource scarcity, improvisational skills allow SMEs to creatively identify alternative materials or suppliers, ensuring continuous production without compromising sustainability objectives (Levallet et al., 2024). Improvisation also helps organizations respond quickly to supply chain disruptions, particularly when traditional linear systems fail due to resource shortages or regulatory changes, which are common in emerging economies (Liu et al., 2018).

In implementing CE, improvisation helps SMEs foster collaboration and knowledge sharing, both internally and externally. For instance, in industries where partnerships are essential for closing loops (e.g., through sharing recycled materials), improvisation helps SMEs form creative alliances that optimize the use of available resources (Shahzad et al., 2023). Given that SMEs often operate with limited resources, the ability to improvise is helpful for maximizing their contribution to CE. By creatively sourcing alternative materials or modifying designs to reduce dependency on scarce resources, it can be managed to continue operations while adhering to CE principles (Rodríguez-Espíndola et al., 2022). Additionally, improvisation supports eco-innovation in SMEs, as it encourages employees to propose sustainable solutions when facing prompt environmental challenges, aligning with the broader goals of CE. Moreover, SMEs can improvise to experiment with business models that support CE, such as adopting pay-per-use models or leasing rather than selling products. These models not only reduce resource consumption but also create long-term customer relationships, promoting product reuse and recycling (Tukker, 2015). As SMEs in developing economies often lack access to large-scale technological solutions, improvisation allows them to innovate with the limited tools and resources available, making progress towards CE more feasible. So, we can hypothesize:

Hypothesis 2: *Improvisation will exert a positive effect on the circular economy.*

HRM, improvisation, and circular economy

While CE has garnered attention for its potential to foster sustainable development (De Angelis, 2024), its implementation, particularly within SMEs, seems to be complex and multifaceted. A critical element in this journey is human resources (HR), as the success of CE heavily relies on the ability of organizations to foster a culture of innovation and adaptability (Bocken et al., 2016b; Pan et al., 2024).

HRM systems can promote a circular mindset by providing employees with training, knowledge-sharing platforms, and opportunities to develop skills in resource efficiency, waste reduction, and product lifecycle management (Shahzad et al., 2023). Singh et al. (2025) also explores how recruitment, training, and performance evaluation influence the implementation of digital circular economy models. However, several challenges hinder the widespread adoption of CE practices, especially within SMEs especially in contexts like Iran. These challenges include cultural resistance to change, limited financial and technical resources, rigid organizational structures that impede flexibility (Lieder and Rashid, 2016) and so forth. Moreover, the implementation of CE often requires organizations to venture into uncharted territories, where traditional risk-averse cultures and a lack of experience in sustainable innovation act as barriers (Ghisellini et al., 2016).

Improvisation emerges as a critical factor in addressing these challenges by fostering adaptability, creativity, and resilience in (Vera and Crossan, 2005). In the context of CE, improvisation allows SMEs to explore innovative solutions to resource efficiency and waste management, even when operating under constraints such as limited financial resources or technological capabilities (Levallet et al., 2024). For example, a small manufacturer may face challenges in sourcing sustainable materials. Through improvisation, the company could

innovate by repurposing locally available waste materials, thus contributing to the CE while reducing costs. This capacity for exploration and experimentation is particularly important for SMEs that must remain agile to adapt to the dynamic requirements of CE practices (Elf et al., 2022). Improvisation not only helps SMEs navigate the dynamic challenges of CE but also addresses operational needs. On a day-to-day basis, operational capabilities are essential for executing existing processes efficiently and effectively (Winter, 2003). Improvisation in this context allows SMEs to mobilize resources, allocate tasks, and resolve immediate issues without significant disruptions to the overall operation (Essuman et al, 2023). For instance, when an SME faces a sudden technical failure in its recycling process, employees who can improvise are better equipped to find quick solutions, minimizing downtime and ensuring operational continuity (Açıkgöz et al., 2023). Moreover, improvisation supports the exploitation of existing capabilities by allowing firms to fine-tune their operations for maximum efficiency. SMEs' employees with strong improvisation capabilities are better positioned to adapt their processes to CE requirements, such as reducing waste or optimizing resource use (Levallet et al., 2024). This adaptability is crucial for sustaining CE practices and achieving long-term operational efficiency. Regarding all above, we can hypothesize:

Hypothesis 3. *The effect of HRM systems on the circular economy is mediated by team improvisation.*

Digital Technology and its Interplay with HRM and Improvisation

Digital technologies (DT) like AI, cloud computing, IoT, and blockchain significantly transform business practices and fuel innovation and value generation within companies (Huiping, 2024). Digital technologies have emerged as critical strategic assets, playing a key role in reshaping business processes (Issah and Calabro, 2024) and enhancing improvisational capabilities within SMEs. These technologies enable organizations to navigate operational and

dynamic challenges effectively, fostering sustainability and CE practices (Balasubramanian et al., 2024). By integrating the Resource-Based View (RBV) and contingency theories, DT is shown to moderate the effect of improvisation and HRM on CE outcomes within SMEs. Digital technology refers to tools such as IoT, big data, cloud, Blockchain, artificial intelligence and so forth, which allow SMEs to optimize resource use and enhance decision-making capabilities (Teece, 2018). For SMEs pursuing CE, DT enables real-time data processing and flexible responses to sustainability challenges (Kamble and Gunasekaran, 2023). For instance, a small manufacturer can employ real-time analytics to optimize material usage, reducing waste and contributing directly to CE goals. As the RBV suggests, digital technology becomes a critical resource for SMEs, supporting competitive advantages by enhancing the firm's ability to adapt to complex and evolving market demands (Barney, 1991). By enabling SMEs to respond to operational challenges with precision, DT supports the adjustment of existing protocols, leading to more sustainable and efficient CE practices.

Meanwhile, improvisation is crucial when SMEs encounter unforeseen circumstances, and DT plays a vital role in facilitating this process. For instance, DT provide rapid access to data and insights, allowing teams to make informed, real-time decisions. This dynamic capability transforms improvisation from a spontaneous reaction into a structured, data-driven process. For example, an SME facing a supply chain disruption can use predictive analytics and AI to quickly find alternative suppliers, minimizing downtime while maintaining CE operations (Chen et al., 2023; Kusi-Sarpong et al., 2023). Furthermore, DT enhances SMEs' ability to respond dynamically to changing conditions, turning improvisation into a systematic method for tackling sustainability challenges. As described by RBV, this capability not only addresses immediate operational concerns but also fosters long-term strategic innovation. For instance, an SME using smart manufacturing technologies can recalibrate its production processes to reduce energy consumption, contributing to both operational efficiency and CE

goals (Winter, 2003). This real-time adaptability enabled by DT is critical for advancing CE and resource utilization.

The interplay between digital technology and HRM systems is equally important for advancing CE within SMEs as well. DT amplifies HRM by enhancing collaboration, knowledge sharing, and skill development among employees. The broader the scope of digital tools within an organization, the more innovative HRM systems become, creating an environment that supports CE practices (Collins and Smith, 2006). Digital platforms such as cloud-based collaboration tools allow geographically dispersed teams to share insights in real-time, increasing employees' creative potential and enabling them to combine diverse data into innovative CE strategies. Kouhizadeh et al (2020) highlighted that Blockchain technology, will facilitate circular economy practices when there is regulatory or institutional backing to ensure effective contract enforcement.

Moreover, digital technology supports continuous learning within HRM systems, giving extra cognitive resources to do their task (Liu et al, 2024b), which would be an essential factor in CE success. SMEs can train employees on the latest CE innovations through digital learning platforms, ensuring they adapt to emerging sustainability trends and remain at the forefront of innovation (Zollo and Winter, 2002).

The integration of digital technology into HRM systems also enhances improvisation while strengthening the CE framework within SMEs. DT allows HRM systems to access a broader range of knowledge and ideas, which can be creatively recombined into innovative CE solutions (Becker and Huselid, 2006). This synergy between DT and HRM ensures that SMEs remain agile and responsive to evolving market demands, leveraging digital tools to explore new opportunities and optimize resource allocation for CE. For example, an SME in the electronics industry might use digital tools to analyse product lifecycle data and develop

strategies for extending product lifespans, reducing waste, and aligning with CE principles. Digital technology ensures that CE practices remain relevant (Kazancoglu et al., 2023; Mishra et al., 2024) and effective over the long term, allowing SMEs to maintain their competitive advantage in the global market (Neri et al., 2024).

Thus, digital technology not only strengthens the relationship between improvisation and CE but also moderates the impact of HRM systems on CE, making it a vital resource for SMEs aiming to succeed in the CE. So, we can hypothesize:

Hypothesis 4a: *Digital technology moderates the association of HRM systems and improvisation; as such, the association is higher when DT is high.*

Hypothesis 4b: *Digital technology moderates the association of improvisation and CE; as such, the association is higher when DT is high.*

Methods

Research context

The intersection of Human Resource Management (HRM) systems and the CE is an evolving area of study that has primarily been examined in developed nations. However, there remains a significant knowledge gap concerning how CE practices unfold in developing countries, particularly within contexts marked by institutional adversity, such as Iran. Iran faces distinct economic and regulatory challenges—including international sanctions, inflationary pressures, currency instability, and restricted access to global markets—that create pervasive institutional voids (Pak et al, 2023). These voids result in the absence or weakness of formal market-supporting institutions, compelling firms to rely more heavily on internal organizational

capabilities and informal routines. In this environment, HRM systems not only serve as strategic assets but also act as institutional substitutes, helping firms build the capacity to navigate uncertainty and adapt to fluid constraints. Furthermore, Iranian organizational culture—shaped by collectivism, hierarchical structures, and strong interpersonal trust—can significantly influence how improvisation is enacted, sustained, and perceived as a legitimate response to resource scarcity (Javidan, M., & Dastmalchian, 2003). Studying improvisation in this setting thus provides a unique lens to examine how HRM practices support real-time problem-solving in conditions where traditional planning and formalization are often impractical. By deepening our understanding of how CE-oriented HRM strategies function in Iran, this study contributes to broader theorizing on how firms in resource-constrained, institutionally volatile environments can leverage human capital agility for sustainable innovation.

Participants and Procedures

This study focuses on Iranian small and medium-sized enterprises (SMEs) to analyse how challenges related to the CE can be effectively addressed in this context. Iran has faced enduring economic difficulties, particularly due to international sanctions impacting its financial systems, trade, and access to critical production materials. These sanctions have limited the import of essential raw materials and technologies, causing significant bottlenecks in key sectors such as manufacturing, energy, and even healthcare (Farzane et al., 2022). The restrictions on global market access, combined with the volatility of oil revenues, have compelled Iranian SMEs to seek alternative economic models. This pursuit for sustainability and resource optimization creates an environment ripe for exploring innovative HRM strategies that can facilitate the adoption of CE practices (Amuzegar, 2004). On the other hand, the

majority of businesses in Iran, approximately 75%, are classified as small and medium-sized enterprises (SMEs). In this line, the adoption of CE practices in Iranian SMEs can provide a dual benefit: addressing environmental sustainability (Korhonen et al., 2018) and creating new economic opportunities (Kirchherr et al., 2018; Mangla et al, 2018) for this developing country. To explore this sector, we initiated a screening of product profiles and identified companies engaged in sustainable practices related to the CE over the past five years.

Our study adhered to ethical guidelines throughout the research process. All participants were fully informed of the study's purpose and procedures, and informed consent was obtained. Their responses were anonymized to ensure confidentiality and protect privacy. The sample comprised 760 Iranian SMEs, each employing fewer than 250 individuals, as defined by European standards. Participants were informed that their involvement was voluntary, and they had the right to withdraw at any time without penalties or adverse consequences.

Additionally, to ensure the presence of an organized HRM system, we further refined our sample, resulting in a total of 520 eligible companies for our analysis. This classification includes a diverse array of businesses, from small artisanal operations to advanced technological firms. The surveyed SMEs represent a diverse array of industries, including manufacturing—including automotive parts, textiles, and clothing—alongside information technology firms such as software developers and IT support providers. Agriculture-focused SMEs, including organic farms, were also part of the group. The retail sector featured businesses like specialty grocery stores and e-commerce platforms that offer eco-friendly products. We included professional services, such as accounting firms, marketing agencies, and legal consultancies, to ensure comprehensive representation across various sectors.

To recruit participants, we contacted a broad sample of Iranian SMEs via email (over 500 SMEs as discussed above), explaining the study's aims and ensuring confidentiality. Of

those approached, 106 SMEs agreed to participate, all of which met our inclusion criteria of having more than 10 employees and at least three organizational tiers (top/middle management and employees)- showcasing an established HRM system. A total of 384 questionnaires were returned, with each SME providing at least three completed responses, thereby ensuring within-firm triangulation. To provide further clarity, the sampling approach was purposive and stratified by industry and firm size to enhance sectoral representativeness. However, the study did not involve a probabilistic sampling frame, and thus we do not report a formal sampling error. While statistical generalizability is limited, the sample reflects substantial heterogeneity in SME size, sector, and internal organizational structure, supporting the analytical depth and contextual relevance of our findings.

Furthermore, to enhance construct validity, we first conducted pre-testing and expert interviews with five senior HR professionals who were familiar with CE concept, and three academic experts in HRM and CE. Based on their feedback, we refined the items for contextual clarity and conceptual fit. The final questionnaire employed previously validated multi-item scales adapted to the SME and Iranian context.

Improvisation was measured using the well-established scale proposed by Vera and Crossan (2005), which conceptualizes improvisation as consisting of spontaneity, creativity, and real-time action. This structure aligns with the complex, rapidly shifting operating conditions of SMEs in institutional voids, making it especially appropriate for the Iranian context where formal planning is often constrained. Confirmatory Factor Analysis (CFA) supported the dimensional structure of improvisation, with all items loading significantly ($\lambda > 0.70$), and the overall scale showing strong internal consistency (as reported in table 1).

To reduce common method bias, we implemented a multi-source and multi-wave data collection design. Independent variables (e.g., HRM practices) were completed by HR or

middle managers, while dependent variables (e.g., CE innovation outcomes) were assessed by operational staff. Improvisation items were split between middle managers and team leaders, based on their direct observation of employee behaviour. This cross-role approach helped separate perceptual sources. Further, Harman's single-factor test indicated no general factor accounted for the majority of covariance, and a marker-variable technique confirmed the absence of serious bias. Additionally, to further minimize the potential for common-method bias and causality, data were collected at 3 distinct time points between 2022 and 2023. In the initial phase (T1), top managers were requested to provide information regarding various attributes of their SMEs (as control variables), including age, size (measured by the number of employees), area of activity, and the scope of operations (national or international). Concurrently, employees completed a survey designed to gather insights into the HRM system and the integration of digital technology within the SME. A follow-up assessment (T2) was conducted 6 months later to evaluate the construct of improvisation capability, which was assessed again through responses from the employees. After one year had passed since T1, CE as the dependent variable, was measured by middle managers such as human resource managers, R&D managers, and executive managers, who generally operated within organizational roles related to sustainability or overall management (T3). This approach not only enriches the data collected but also strengthens the reliability of the findings. As a result, we received 384 fully completed questionnaires encompassing all relevant constructs.

All constructs were assessed for construct reliability and validity. Cronbach's alpha for all scales exceeded the 0.70 threshold (Table 1). Convergent validity was verified via AVE scores above 0.50, while discriminant validity was confirmed using the Fornell-Larcker (1981) criterion and HTMT ratios (< 0.85 for all constructs).

To increase the credibility and generalizability of our findings, we conducted several robustness checks and post-hoc analyses. First, to assess potential reverse causality between

improvisation and CE practices, we tested an alternative model where CE was treated as the predictor of improvisation. This reversed model yielded a significantly poorer fit ($\Delta\chi^2 = 34.7$, $p < .01$), and the path from CE to improvisation was not statistically significant ($\beta = 0.09$, $p > .10$), thereby supporting the theorized directionality of our original model.

Second, we performed subgroup analyses to examine the consistency of mediation and moderation effects across different industry sectors (e.g., manufacturing, IT, agriculture, retail, professional services) and firm sizes (regarding employees number). Multi-group analyses showed that the core relationships in our model held consistently across industries, though the strength of the improvisation-CE link was stronger in manufacturing and IT sectors, possibly due to the higher pace of change and resource constraints in these fields.

Additionally, to address concerns about the relatively small number of respondents per firm (average < 4), we assessed within-group agreement using the rwg(j) index for key constructs (e.g., improvisation, CE, HRM systems). All indices exceeded the recommended threshold of 0.70 (mean rwg(j) = 0.76), suggesting acceptable agreement within firms. To account for potential nesting effects, we tested a two-level hierarchical linear model (HLM) with employees nested within firms. The intra-class correlation coefficients (ICCs) for key dependent variables were low (all ICCs < 0.07), indicating that firm-level clustering had minimal impact on the observed effects, justifying our treatment of data at the individual level. In addition, all key relationships were re-estimated using bootstrapping with 5,000 resamples to verify the stability of mediation and moderation paths. Confidence intervals remained robust, further affirming the validity of our findings.

We employed hierarchical regression analysis to test our hypotheses. This method allows for stepwise examination of the incremental variance explained by different blocks of variables, making it particularly suited for analysing interaction effects and testing mediation

or moderation hypotheses (Cohen et al., 2013). In the first step, we entered control variables, followed by the main predictors (e.g., HRM system, digital technology, organizational improvisation), and finally the interaction terms. This structured approach provides a clear assessment of each variable's unique contribution to the outcome variable—namely, Circular Economy (CE). Hierarchical regression was deemed appropriate for several reasons. First, our research aimed to explore how HRM systems, digital technology adoption, and organizational improvisation independently and jointly influence CE practices—an inquiry that necessitates evaluating the effect of adding one predictor set over another. Second, the method is robust in handling continuous variables and allows for testing complex relationships without violating assumptions of linearity or multicollinearity when diagnostics are properly assessed. Third, it offers a transparent and interpretable way to detect interaction effects, which is central to our interest in understanding capability bundling in SMEs.

Prior to running the regression, we conducted diagnostics for multicollinearity, including Variance Inflation Factor (VIF) checks for all independent variables, with values well below the recommended threshold of 5 (mean VIF = 2.17). Heteroskedasticity was tested using the Breusch-Pagan test, with non-significant results confirming homoscedasticity. We also checked for model specification errors using the Ramsey RESET test, which did not indicate any significant omitted variable bias. Together, these procedures enhance the robustness and reliability of our empirical claims regarding the constructs and their role in our model.

Measurements

We employed established measurement frameworks that align with our research objectives to assess our model. The variables under investigation were evaluated using standardized questionnaires. Table 2 provides a summary of the variables and their operational definitions.

Given that the survey involved Iranian participants, a back-translation method was implemented to maintain conceptual consistency (Chan et al., 2016). The survey was first created in English and subsequently translated into Persian by two bilingual experts. Prior to the survey's distribution, we engaged in comprehensive interviews with managers from SMEs to establish both the content and face validity. Following this, several management experts reviewed and refined the measures. Additionally, a focus group discussion and a pilot study involving 30 respondents contributed to enhancing the clarity and validity of the measurement items. These managers examined the questionnaires for possible wording concerns, including inappropriate items, bias, and ambiguity. To increase the validity of our results, we utilized a Likert scale, which is one of the most widely recognized measurement tools available. This scale ranges from 1, representing "strongly disagree," to 5, signifying "strongly agree." It was employed to gauge the extent of respondents' agreement with each statement, except for the digital technology aspect.

HRM system. Adapted from the research conducted by Lee et al. (2019), a 17-item metric was utilized to evaluate HRM systems, focusing on three critical dimensions: ability, motivation, and opportunity. One illustrative item from this assessment states, "When new group members are selected for my team, their creative abilities are heavily considered in the decision-making process." Additionally, a comprehensive HRM index was adopted, which encompasses the full spectrum of HR practices. This holistic index has been extensively utilized in strategic HRM research, emphasizing that a thorough understanding of the effects of HR practices is best attained through an analysis of the entire HRM system, rather than by examining individual practices in isolation (Liao et al., 2009; Chuang et al., 2016).

Organizational improvisation. Informed by the framework established by Moorman and Miner (1998), we adopted specific criteria to evaluate organizational improvisation. This assessment involved soliciting input from employees across various levels regarding the

development and execution of plans within their units. To measure organizational improvisation, we employed seven statements adapted from the works of Vera and Crossan (2005) and Liu et al. (2018). These statements included: "Addressing unexpected events promptly," "Demonstrating quick thinking during implementation," "Responding in real-time to unforeseen challenges," "Exploring innovative problem-solving strategies," "Identifying opportunities for process enhancement," "Embracing risks by generating creative ideas during tasks," and "Exhibiting originality in our work."

Circular Economy. To measure Circular Economy (CE) performance, we adopted the 9R framework, one of the most comprehensive and widely recognized models for evaluating CE activities (Dragan et al., 2024; Reike et al., 2022). This framework includes nine hierarchical strategies: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, and Recycle, capturing both upstream and downstream CE practices. Each of these components was measured using a 5-point Likert scale (1 = Not Practiced, 5 = Highly Practiced), where respondents assessed the extent to which each strategy was implemented within their organization. We treated the CE construct as reflective, based on theoretical assumptions that these dimensions represent manifestations of a broader, latent CE orientation. This approach aligns with prior empirical studies (e.g., Kirchherr et al., 2018; Ghisellini et al., 2016) and was supported by the results of our Confirmatory Factor Analysis (CFA). All nine items loaded significantly on a single factor ($\lambda > 0.65$), indicating convergent validity. The model showed acceptable construct reliability (see table 1), confirming internal consistency and convergent validity. Discriminant validity with other latent variables was confirmed using the Fornell-Larcker (1981) criterion and HTMT ratios (< 0.85) as discussed earlier. Fit indices for the measurement model were within acceptable thresholds ($\chi^2/df = 1.98$; CFI = 0.95; RMSEA = 0.048; SRMR = 0.041), supporting the structural integrity of the CE measurement model.

Digital technologies. The framework for digital technologies utilized in this study is adapted from the works of Neri et al. (2024), encompassing a total of several components. These components include the Internet of Things, Cloud computing, Big data analytics, Artificial Intelligence (AI), Machine learning, Autonomous robots, Augmented reality/ Virtual reality, Information and communication technology (like smartphone), Additive manufacturing, Cybersecurity and Blockchain. One open question was included in the questionnaire asking if they use any digital technologies other than those on the available list. These advanced technologies have been seamlessly integrated to achieve a synergistic effect (Ivanov et al, 2019). Consequently, our research employed a reflective model to assess the implementation of digital technologies. Participants were asked to indicate the extent to which their organizations have adopted these technologies within their operational frameworks using a Likert scale, ranging from 1 (not Practiced) to 5 (Highly Practiced).

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Please insert Table 2 here.

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Results

This section presents the empirical findings of the study, structured to address the hypothesized relationships between HRM systems, improvisation, circular economy (CE) adoption, and the moderating role of digital technology (DT). The analysis begins with descriptive statistics and bivariate correlations, followed by hierarchical regression models testing direct, mediated, and

moderated effects. All analyses were conducted using standardized coefficients, with significance levels set at $p < 0.10$, $*p < 0.05$, and $**p < 0.01$.

Table 3 summarizes the means, standard deviations, and Pearson correlations for all variables. The sample comprised 384 respondents from SMEs, with an average age of 12.22 years (SD = 3.45) and a mean size of 72.3 employees (SD = 5.3). Key variables exhibited sufficient variability, with HRM systems (Mean = 4.20, SD = 1.01) and improvisation (Mean = 3.35, SD = 1.24) scoring moderately, while CE adoption averaged 3.84 (SD = 0.77). A strong positive correlation emerged between HRM systems and improvisation ($r = 0.52$, $**p < 0.01$), preliminarily supporting Hypothesis 1 (H1). Similarly, improvisation correlated strongly with CE adoption ($r = 0.58$, $**p < 0.01$), aligning with Hypothesis 2 (H2). Critically, HRM systems showed no significant direct association with CE ($r = 0.09$), reinforcing the hypothesized mediation mechanism (H3). Digital technology (DT) correlated moderately with HRM ($r = 0.33$, $**p < 0.01$) and improvisation ($r = 0.28$, $**p < 0.01$), providing a foundation for testing its moderating role (H4a, H4b). These patterns suggest that HRM's influence on CE is channelled indirectly through improvisation, while DT may amplify key relationships.

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To formally test the hypotheses, hierarchical regression models (table 4) were estimated for improvisation (Models 1–3) and CE adoption (Models 4–6). Control variables (SME age, size, scope) were included in all models. In Model 1, controls explained minimal variance in improvisation ($R^2 = 0.05$), with only SME size showing marginal significance ($\beta = 0.08$, $p < 0.10$). Adding HRM systems in Model 2 (Direct Effects) significantly improved model fit ($\Delta R^2 = 0.26$, $**p < 0.01$), with HRM exhibiting a strong positive effect on improvisation ($\beta =$

0.42, $p < 0.01$), confirming H1. Introducing the HRM × DT interaction in Model 3 (Moderation) further enhanced explanatory power ($\Delta R^2 = 0.03$, $^*p < 0.05$). HRM remained significant ($\beta = 0.39$, $^{**}p < 0.01$), while the interaction term ($\beta = 0.15$, $^*p < 0.05$) indicated that DT strengthens the HRM-improvisation link, supporting H4a.

For CE adoption, Model 4 showed that controls accounted for 10% of CE variance ($R^2 = 0.10$), with SME size again marginally influential ($\beta = 0.07$, $p < 0.10$). Including HRM and improvisation in Model 5 (Direct and Mediated Effects) explained 48% of CE variance ($\Delta R^2 = 0.38$, $^{**}p < 0.01$). Improvisation had a large effect ($\beta = 0.52$, $p < 0.01$), confirming H2, while HRM's direct effect was small and non-significant ($\beta = 0.08$), consistent with full mediation (H3). Adding the Improvisation × DT interaction in Model 6 (Moderation) increased R^2 to 0.53 ($\Delta R^2 = 0.05$, $^{**}p < 0.01$). Improvisation remained robust ($\beta = 0.49$, $^{**}p < 0.01$), and the interaction term ($\beta = 0.21$, $^{**}p < 0.01$) revealed that DT amplifies the improvisation-CE relationship, validating H4b.

To quantify the indirect effect posited in H3, bootstrapped mediation analysis (PROCESS Macro Model 4, 5,000 resamples) was conducted. Results confirmed that HRM systems exerted a significant indirect effect on CE through improvisation ($\beta = 0.22$, $^{**}p < 0.01$; 95% CI [0.14, 0.30]). The residual direct effect of HRM on CE was non-significant ($\beta = 0.07$, $p = 0.15$), while the combined direct and indirect pathways were significant ($\beta = 0.29$, $^{**}p < 0.01$), with improvisation mediating 76% of HRM's total impact. This confirms H3: HRM drives CE adoption almost entirely through fostering improvisation.

Simple slope analyses (Aiken & West, 1991) clarified the nature of DT's moderating effects (H4a, H4b). For H4a, at high DT levels (+1 SD), HRM's effect on improvisation was stronger ($\beta = 0.54$, $^{**}p < 0.01$) versus low DT (-1 SD: $\beta = 0.24$, $^*p < 0.05$). For H4b, high DT intensified the improvisation-CE relationship ($\beta = 0.70$, $^{**}p < 0.01$) compared to low DT ($\beta =$

0.28, *p < 0.05). Thus, DT acts as a catalyst, enhancing both HRM's capacity to spur improvisation and improvisation's efficacy in driving CE.

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In summary, the findings support all hypotheses: HRM systems strongly predict improvisation (β = 0.42***, H1), improvisation drives CE adoption (β = 0.52***, H2), HRM's effect on CE is fully mediated by improvisation (indirect β = 0.22***, H3), DT strengthens the HRM-improvisation link (β = 0.15**, H4a), and DT amplifies the improvisation-CE relationship (β = 0.21***, H4b). These results underscore the critical role of improvisation as a mediator and DT as a moderator in the relationship between HRM systems and CE adoption, providing valuable insights for both theory and practice.

Discussion

Although there has been considerable advancement in Circular Economy research, there is still insufficient knowledge about the contribution of HRM in promoting CE initiatives within organizations (Jabbour and de Sousa Jabbour, 2016; Chowdhury et al., 2022). This study, informed by HRM literature, employs a novel approach to explore how HRM systems affect CE practices, especially in SMEs. Utilizing a time-lagged research design and a relatively large sample, this research fills a crucial gap by investigating the influence of HRM systems on CE, with a particular emphasis on the mediating role of improvisation in enhancing CE initiatives.

This research also highlights the specific aspects of digital technologies and their significance as contingency factors, offering important insights into the indirect impact of HRM systems on CE. It specifically identifies improvisation as a crucial mediator that helps organizations respond more swiftly to CE challenges. Furthermore, this adaptability is influenced by digital technologies, which improve decision-making and operational agility in SMEs. For instance, technologies like artificial intelligence, automation, and data analytics enable firms to dynamically adjust to environmental shifts and resource limitations, thereby strengthening their CE practices (Teece, 2018).

These findings are not only theoretical but also serve as practical guidance for SMEs, offering them a framework to strategically navigate the uncertain terrain of CE. By fostering a deeper understanding of how HRM systems and improvisational capabilities interact with digital technologies, SMEs can better adapt to evolving sustainability requirements, ultimately catalysing their journey toward sustainable practices. This strategic alignment of HRM, improvisation, and digital technologies paves the way for organizations to become more resilient, agile, and effective in implementing CE initiatives.

Implication for Theory

This study offers important theoretical contributions to three interconnected domains: organizational improvisation, strategic HRM and sustainability, and digital contingency theory. First, we extend the Resource-Based View (RBV) by advancing improvisation as a dynamic, cultivable capability—rather than a spontaneous or reactive behaviour. While RBV traditionally emphasizes path-dependent, cumulative resource development (Barney, 1991), our findings reveal that improvisation can be intentionally nurtured by opportunity-enhancing HRM systems, creating agile routines capable of responding to CE imperatives. In uncertain

and institutionally volatile settings like Iran, improvisation becomes a strategic resource that mediates the HRM-sustainability relationship. This supports emerging RBV extensions that view capabilities as flexible, socially embedded, and responsive to real-time demands. Our study challenges the assumption that structure and spontaneity are conceptually opposed, illustrating how structured HRM mechanisms can intentionally create the space for creative deviation and adaptive action—particularly under environmental uncertainty.

Second, we expand the AMO (Ability-Motivation-Opportunity) framework by empirically demonstrating how opportunity-enhancing HRM practices serve as a behavioural infrastructure for improvisation in CE contexts. Our findings contribute to the growing body of scholarship at the intersection of HRM and sustainability (Aust et al., 2020; Ren et al., 2023). While AMO theory is often applied to explain performance outcomes (Appelbaum et al., 2000; Jiang et al., 2021), we demonstrate its utility in fostering capability emergence, specifically improvisation.

While prior research has explored how HRM influences environmental performance or employee engagement (Singh et al., 2025), our study reveals that HRM systems indirectly foster CE practices by cultivating improvisational behaviour, which in turn supports rapid adaptation and experimentation in sustainability practices. This offers a new perspective on how strategic HRM contributes to capability development beyond traditional performance metrics—specifically, in enabling the internalization of CE principles. Our results highlight that HRM systems fostering autonomy, learning, and decision discretion enable employees to deviate productively from standard routines, which is critical in contexts requiring circular innovations. This contributes to ongoing theoretical debates on the role of agency and discretion in HRM–sustainability integration (Ren et al., 2023).

Third, we extend contingency theory and enrich emerging perspectives on digital transformation by demonstrating that the impact of HRM on CE is contingent upon the integration of digital technologies. While Sadiq et al. (2025) stated that enhancing firms' capabilities enables them to leverage digital technologies (such as knowledge management systems) to attain circularity, our research shows that the interaction of HRM, improvisation, and digital technologies reveals a layered capability-building process. Technologies like AI and big data analytics not only augment operational efficiency but also enhance improvisational responsiveness—suggesting that improvisation becomes most effective when digitally augmented. This deepens our understanding of how digital technologies condition the efficacy of organizational routines in high-uncertainty environments.

Finally, by anchoring our study in the context of Iranian SMEs, we contribute a context-sensitive theoretical lens to capability development. Institutional adversity, including sanctions, inflation, and policy volatility, creates conditions where formal planning is often infeasible, making improvisation not only beneficial but necessary. This provides a theoretically rich case of improvisation under institutional voids, adding to global HRM and CE literature by demonstrating how capabilities may form differently under structural constraints. Specifically, SMEs in emerging markets face acute limitations in access to financial, technological, and human resources, which can hinder the adoption of CE practices (Ranta et al., 2021). However, these constraints also generate unique opportunities for experimentation, frugal innovation, and collaborative problem-solving, which can accelerate CE transitions in resource-scarce environments (Suchek et al., 2021). The Iranian context illustrates how SMEs can creatively embed circularity into business models, and rely on agile, cross-functional teams to adapt CE principles pragmatically, often without external institutional support.

Implications for Practice

Our study provides valuable insights for SME managers aiming to incorporate circular economy principles within dynamic and resource-limited environments. Sivaiah and Vinodan (2025) demonstrated how SMEs can successfully integrate sustainability into their business models by utilizing internal resources and adopting innovative technologies and circular economy principles. A key takeaway of our research, however, is the need for a deliberate cultivation of improvisation as a strategic organizational capability, rather than allowing it to develop informally. Consistent with the Resource-Based View, our findings suggest that improvisation constitutes a valuable, rare, and hard-to-imitate resource—especially in developing economies where traditional capabilities are constrained.

Building on the AMO framework, our results underscore that improvisation is not merely an emergent trait but a strategic capability that can be deliberately fostered through targeted HRM practices. Rather than relying on informal, ad hoc behaviours, firms should intentionally design HRM systems that cultivate employees' ability to act creatively and responsively under uncertainty.

In many SMEs, structured training programs may be absent, but improvisational skills remain attainable through cost-effective, informal, and experiential learning methods. Job rotation and exposure to various functions can enhance employees' adaptability and knowledge. After-action reviews and reflective sessions following projects facilitate learning from experiences, while encouraging small-scale experimentation empowers employees to test ideas and adapt based on their outcomes. Additionally, peer coaching and mentoring allow seasoned staff to model adaptive thinking and responsive behaviours. Collectively, these approaches help integrate improvisation into the organizational culture, making it a natural component of daily operations even without formal training frameworks.

To foster improvisational thinking, managers should align human resource management practices with this goal. This includes incorporating adaptability, creativity, and problem-solving into recruitment and performance evaluation criteria. Establishing reward and recognition systems that highlight innovative responses to environmental challenges reinforces such behaviour. Furthermore, promoting a psychologically safe environment encourages employees to view mistakes as learning opportunities rather than failures, thereby supporting risk-taking and experimentation. In this context, improvisation should be regarded not merely as a reactionary response but as a proactive process, backed by HRM strategies to drive sustainability and innovation.

Moreover, regarding contingency theory we can posit that the effectiveness of HRM systems depends on their alignment with environmental conditions and enabling technologies. Digital technologies can significantly enhance employees' improvisational capabilities. Managers should explore how such tools can support real-time decision-making through technologies like the Internet of Things and mobile applications, improve adaptability and foresight using big data analytics and artificial intelligence, facilitate rapid prototyping, and offer immersive training environments through augmented and virtual reality. Even straightforward and affordable technologies, such as collaborative platforms, instant messaging, or cloud-based knowledge repositories, can promote improvisation if deliberately leveraged for effective communication and swift decision-making.

Recognizing that improvisation is often a collective endeavour, managers should focus on integrating it into team processes. Assigning diverse teams to circular economy projects allows for a broader range of perspectives. Rotating team leadership fosters shared responsibility and responsiveness, while empowering lower-level teams with autonomy in real-time decision-making enhances overall adaptability. These methods embed improvisation into

the fabric of how work is organized and executed, shifting it from being merely an individual skill to a core team dynamic.

To maintain competitiveness in an ever-evolving landscape, SMEs should continuously evaluate and align their HRM systems and digital tools. Investing in straightforward yet scalable digital platforms that support collaborative learning and agile work practices will help institutionalize improvisation as a strategic response to challenges posed by the circular economy.

Limitations and Future Research

While our study provides valuable insights into the mediating role of improvisation in HRM-enabled circular economy (CE) practices, several limitations offer pathways for further exploration. First, the study's empirical setting—Iranian SMEs operating under conditions of economic instability and external sanctions—limits the generalizability of our findings. Future research could replicate this study in diverse institutional contexts, including developed economies, emerging markets, and different industry sectors, to assess the broader applicability of our propositions. However, we encourage researchers to go beyond replication by exploring conceptual expansions of improvisation-led CE strategies.

One promising avenue is the role of informal networks—both internal (within the firm) and external (e.g., with suppliers, communities, and industry peers)—in enabling improvisation. Informal networks may substitute for formal training systems or bureaucratic structures in SMEs and foster trust, rapid information sharing, and flexible collaboration, all of which are essential to improvisational problem-solving in CE contexts.

Another direction involves emotional labour and affective dynamics. As CE efforts often require mindset shifts and ethical commitment, future research could explore how employees' emotional engagement, resilience, and values-based improvisation contribute to CE adoption. Understanding how emotional labour intersects with HRM practices (e.g., in leadership, performance appraisal, or employee development) would deepen our knowledge of how improvisation is sustained under stress or uncertainty.

Additionally, the influence of cross-functional teams in fostering improvisation deserves closer attention. CE efforts typically span multiple domains—operations, logistics, marketing, etc.—and require collaboration across traditionally siloed areas. Investigating how interdisciplinary teams coordinate, learn, and improvise together, and what HRM practices support this dynamic, could illuminate critical micro-foundations of circular innovation.

From a methodological standpoint, future studies could adopt longitudinal and multi-level designs to trace how improvisational capabilities evolve over time, especially in response to digital technology implementation or organizational change. Such designs would allow researchers to observe feedback loops between improvisation, learning, and CE outcomes.

Moreover, future research should also consider necessity-driven circular economy practices, especially in resource-scarce or crisis-prone environments, where improvisation may not be a choice but a strategic imperative. Comparing opportunity-driven and necessity-driven CE adoption can help refine theoretical models of capability development.

A notably underexplored yet conceptually adjacent literature concerns the role of serendipity in organizational learning and sustainability innovation. Despite our emphasis on improvisation as a dynamic capability under uncertainty, the study does not explicitly engage with the rich body of work on serendipitous discovery, which shares empirical and theoretical affinities with improvisational processes. Both involve real-time problem solving, emergent

sensemaking, and resource recombination, often under conditions of ambiguity and constraint (Denrell et al, 2003; Cunha et al., 2010).

Recent work has reviewed organizational serendipity and its relevance to strategy and innovation (Busch, 2024). Future research could build on these insights to position improvisation as both a reactive and proactive interface to serendipitous moments—those unplanned discoveries that lead to sustainable innovation. This opens theoretical space to examine how organizations recognize, frame, and enact serendipitous insights in the pursuit of CE. Exploring these processes would also provide a richer account of how HRM systems can cultivate openness, curiosity, and absorptive capacity (Zahra & George, 2002), enabling firms to benefit from such chance encounters.

Moreover, scholars could investigate how serendipity and improvisation interact in the context of digital transformation and sustainability. For example, digital platforms, big data, and real-time analytics may create new opportunities for serendipitous connections among ideas, people, and solutions (George et al, 2021). How firms harness such moments, and how HRM and leadership practices support their enactment, remains an open research question with strategic implications.

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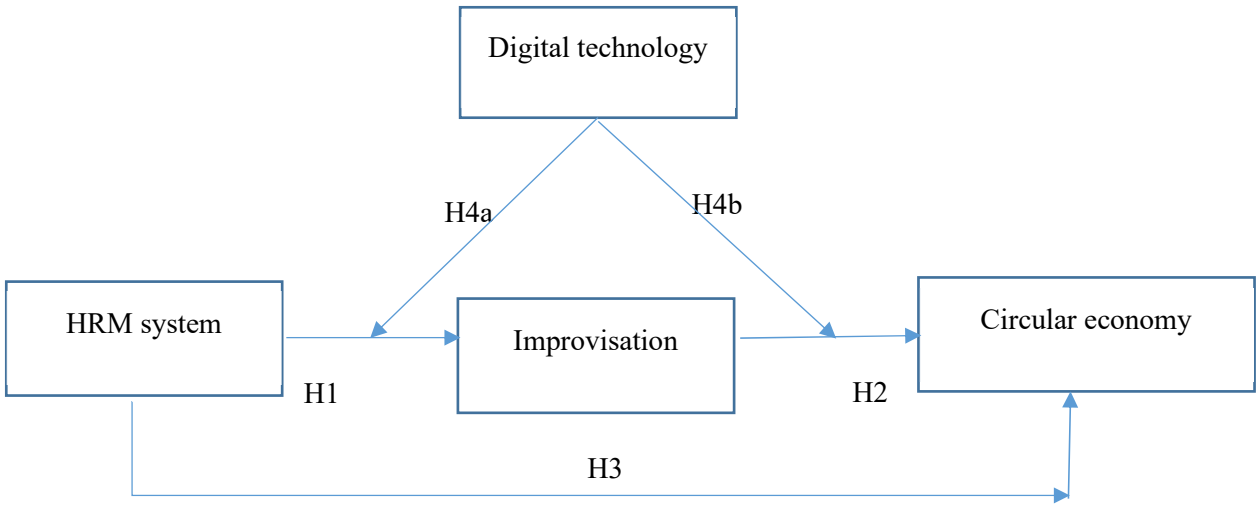

Figure 1. Research model.

Table 1: Constructs and the measurement items

Constructs	Measurement items	Loading	α	CR	AVE
HRM	**Ability**		0.74	0.72	0.55
	When new group members are being selected for my group, their creative ability is weighted heavily in the decision-making.	0.75			
	The process of group member selection in this group emphasizes members' communication skills.	0.73			
	In the process of group member selection in this group, candidates who take an innovative approach are highly preferred	0.74			
	In this group, training is offered, and employees can learn ways of bringing about new work procedures, methods, and ideas.	0.77			
	This group provides training to improve the communication skills of group members.	0.78			
	In this group, training is offered, and employees can learn ways of implementing new ideas.				
	Motivation		0.77	0.79	0.59
	In this group, performance appraisals include evaluation of creative solutions and innovative work procedures and methods.	0.74			
	In this group, performance appraisals include evaluation of how new ideas are implemented.	0.77			
	In this group, performance appraisals include effective communication with other group members.	0.72			
	In this group, employees' incentive plans are based on creative outcomes.	0.77			
	In this group, employees' rewards are closely linked to the generation of innovative outcomes.	0.74			
	The group recognizes and rewards group members who suggest new ideas.	0.71			

	Opportunity		0.75	0.81	0.53
	In this group, employees are involved in job rotation.	0.75			
	In this group, employees are empowered to make decisions in completing their tasks.	0.72			
Improvisation	**Improvisation**		0.72	0.76	0.55
	We deal with unanticipated events on the spot	0.73			
	We think on our feet when carrying out actions	0.73			
	We respond in the moment to unexpected problems	0.71			
	We try new approaches to problems	0.78			
	We identify opportunities for new work processes	0.75			
	We take risks by producing new ideas when doing our jobs	0.71			
	We demonstrate originality in our work	0.72			
Circular Economy	**Circular Economy**		0.72	0.75	0.59
	Refuse	0.75			
	Rethink	0.72			
	Reduce	0.78			
	Reuse	0.81			
	Repair	0.79			
	Refurbish	0.70			
	Remanufacture	0.71			
	Repurpose	0.74			
	Recycle	0.77			
Digital technologies	**Digital technologies**		0.73	0.75	0.58
	Internet of Things	0.78			
	Cloud computing	0.76			
	Big Data Analytics	0.72			
	Artificial Intelligence	0.77			
	Machine Learning	0.74			

Autonomous Robots	0.76
Augmented/Virtual Reality	0.70
Additive Manufacturing	0.70
Information and Communication Technologies (e.g., smartphones)	0.80
Cybersecurity	0.71
Blockchain	0.72

Table 2: Research variables

Variable	Definition	Operationalization	Source
HRM System	A system of human resource practices structured to enhance employees' ability, motivation, and opportunity (AMO).	A 17-item metric adapted from Lee et al. (2019), capturing three dimensions: ability, motivation, and opportunity.	Lee et al. (2019); Liao et al. (2009); Chuang et al. (2016)
Organizational Improvisation	The capacity to react in real time to novel, unstructured problems using spontaneous and creative action.	Seven-item scale adapted from Vera & Crossan (2005) and Liu et al. (2018), grounded in Moorman and Miner (1998).	Moorman & Miner (1998); Vera & Crossan (2005);
Circular Economy (CE)	Extent to which firms apply regenerative strategies that close material loops and reduce resource consumption.	9R framework used to assess CE implementation: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, and Recycle.	Dragan et al. (2024); Reike et al. (2022)
Digital Technology Adoption	Integration of advanced digital technologies into core business and sustainability operations.	Multi-item reflective scale assessing adoption of Internet of Things, Cloud computing, Big Data Analytics, Artificial Intelligence, Machine Learning, Autonomous Robots, Augmented/Virtual Reality, Additive Manufacturing, Information and Communication Technologies (e.g., smartphones), Cybersecurity, and Blockchain.	Neri et al. (2024); Ivanov et al. (2019)

Table 3. Means, Standard deviation and Correlations.

No.	Variable	Mean	SD	1	2	3	4	5	6	7
1	SMEs age	12.22	3.45	1						
2	SMEs size	72.3	5.3	0.14*	1					
3	Scope of SME	0.27	0.27	0.06	0.22**	1				
4	HRM system	4.20	1.01	0.03	0.18**	0.11	1			
5	Improvisation	3.35	1.24	0.05	0.07	0.09	0.52*	1		
6	Digital Technology	3.12	1.04	0.08	0.15*	0.13	0.33*	0.28*	1	
7	Circular Economy (CE)	3.84	0.77	0.02	0.12	0.17*	0.09	0.58*	0.19*	1

N = 384; *p<0.1, **p<0.05, ***p<0.01*

Table 4: **Hierarchical Regression Analysis Results**

Variables	**Improvisation**			**Circular Economy**		
	M1	**M2**	**M3**	**M4**	**M5**	**M6**
Control Variables						
SME age	0.03	0.02	0.02	0.01	0.00	-0.01
SME size	0.08*	0.06	0.05	0.07*	0.05	0.04
Scope of SME	0.04	0.03	0.02	0.05	0.03	0.02
Independent Variable						
HRM	-	0.42***	0.39***	-	0.08	0.07
Moderator						
Digital Technology (DT)	-	0.11	0.10	-	0.10	0.09
Mediator						
Improvisation	-	-	-	-	0.52***	0.49***
Interactions						
DT × HRM	-	-	0.15**	-	-	-
DT × Improvisation	-	-	-	-	-	0.21***
Model Fit						
R^2	0.05	0.31	0.34	0.10	0.48	0.53
Adjusted R^2	0.03	0.29	0.31	0.07	0.46	0.50
ANOVA F	2.10*	15.20***	14.50***	3.20*	22.80***	20.50***

Standardized Beta Coefficients; *p<0.1, **p<0.05, ***p<0.01*