Examining the interplay between managerial ties, dynamic capabilities and innovation climate in driving balanced and combined ambidextrous innovation

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Abstract

Purpose – *This paper aims to adopt the dynamic capabilities view to investigate the relationship between managerial ties (i.e. business and political ties), dynamic capabilities and innovation climate on ambidextrous innovation (i.e. balanced and combined ambidextrous innovation), in the renewable and sustainable energy context. It also examines the mediating effects of dynamic capabilities between managerial ties and ambidextrous innovation (i.e. balanced and combined ambidextrous innovation), and moderating effects between dynamic capabilities and ambidextrous innovation relationships.*

Design/methodology/approach – *Multilevel analyses conducted using AMOS 26 on 288 employees working in 47 UAE energy firms.*

Findings – *Results found that business ties influences balanced and combined ambidextrous innovation indirectly, whereas political ties only impact combined ambidextrous innovation indirectly through dynamic capabilities. Dynamic capabilities insignificantly mediated managerial ties–ambidextrous innovation and political ties–balanced ambidextrous innovation relationships, with stronger indirect effect on combined than on the balanced dimension. Findings also indicate that innovation climate is the crucial moderator between dynamic compatibilities and ambidextrous innovation, as well as balanced and combined ambidextrous innovation, with stronger effect on balanced dimension than the combined.*

Originality/value – *This study addresses recent calls by highlighting the role of dynamic capabilities, an important yet underexplored organizational capabilities in the innovation and ambidexterity literature. Also, this study advances insight into how balanced and combined exploration–exploitation innovation and dynamic capabilities are connected and enhances the understanding into how organizational factors stimulate dynamic capabilities leading to superior innovation.*

Keywords *United Arab Emirates, Managerial ties, Dynamic capabilities*

Paper type *Research paper*

1. Introduction

Firms in the renewable and sustainable energy industry must innovate due to rapid technological improvements and changing regulations (Alfeltra *et al.*, 2023). Management ties (MT), which refer to executives' boundary-spanning activities and relationships with external entities, affect innovation outcomes (Geletkanycz and Hambrick, 1997, p. 654). These links with other businesses or political entities can supply innovation-related resources, information and support (Lyu *et al.*, 2022). The nature and extent of MT influences on balanced and combined ambidextrous innovation (AI) are understudied (Cancela *et al.*, 2022; Fernandes *et al.*, 2023; Hou *et al.*, 2019), because balanced boost innovation, but exploitation-focused firms may struggle to adapt to changing environments

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due to capabilities and knowledge gaps. However, ambidexterity competes for limited organizational resources, so not all organizations can position exploration-exploitation innovation equally.

Organizational capabilities enable new ideas to emerge using current knowledge, expertise and resources while exploring new opportunities (Khaksar *et al.*, 2023). Thus, dynamic capability (DC) enable firms to ambidexterously sense and seize opportunities while adapting resources (Birkinshaw *et al.*, 2016; Thai *et al.*, 2024). DC theory emphasizes learning from outside the firm and combining new and existing knowledge and resources (Gao and Sarwar, 2022; Ilmudeen, 2022). MT and DCs may support firm innovation separately (Birkinshaw *et al.*, 2016; Uzkurt *et al.*, 2023), but more research is needed to understand how they affect AI. DC might be able to explain the connection between MT and AI, but previous studies have mostly looked at how MT dimensions affect innovation (Naqshbandi and Jasimuddin, 2022; Guo *et al.*, 2020), leaving this area of research fragmented and understudied both theoretically and empirically (Saleh *et al.*, 2023). This link must be better understood for several reasons. First, it shows that MT and DC likely complement each other to stimulate innovation (He *et al.*, 2022; Uzkurt *et al.*, 2023). With MT's resources, knowledge and legitimacy, firms can enhance DC. DC allows firms to use MT and integrate external relationships into strategies and innovations (Greven *et al.*, 2022; Teece, 2018). Second, firms must balance (BAI) and combine (CAI) exploration–exploitation activities in AI (He and Wong, 2004). MT and DC may facilitate these processes differently (Wang *et al.*, 2023a, 2023b). By examining how these factors interact, firms can better manage complexities to achieve AI. Third, examining MT and DC together can reveal synergies that may not be obvious when studying them separately. Understanding how these elements interplay allows firms to optimize AI processes and outcomes. Finally, Wang *et al.* (2023a, 2023b) showed that innovation climate (IC) affects network capability and knowledge creation. However, because innovation literature usually looks at DC and AI separately, not many studies look at the boundaries of IC between DC and AI. By moderating, IC bridges these two research streams. Thus, this study builds and empirically examines a framework that integrates MT, DC and IC to enhance ambidexterity and innovation research and better understand how these factors affect AI outcomes. Therefore, this study aims to address the following research questions:

RQ1. Do DC significantly mediate the relationship between MT and AI?

RQ2. Does IC moderate the relationship between DC and AI?

We aim to offer several contributions to this study. Explaining the relationship between MT and AI advances AI research. Much research uses MT as a composite variable, omitting to analyze how each independent facet affects the desired outcomes (Li *et al.*, 2008; Naqshbandi and Jasimuddin, 2022). To bridge this gap, we categorize MT into business and political ties. Second, we address the demand to understand how balanced and combined exploration–exploitation innovation and DC are linked (Wilden *et al.*, 2018). Previous research considered ambidexterity in DC (O'Reilly and Tushman, 2008). Dean (2021) claimed ambidexterity and DC are distinct but related research fields. Thus, we build on previous research (Birkinshaw *et al.*, 2016; Ochie *et al.*, 2022) by exploring how DC mediates MT-AI interactions. This study also uses Wang *et al.*'s (2023a, 2023b) organizational-level AI construct, allowing the firm to distinguish MT and DC-influenced BAI and CAI. Earlier studies have shown that companies can gain from creating DC in balanced and combined forms, as well as in complementary areas of exploitation and exploration (Jansen *et al.*, 2009; Rojas-Córdova *et al.*, 2023; Wilden *et al.*, 2018). This is in response to Dean's (2021) call for more research into the organizational factors that encourage DC and lead to better innovation and knowledge transfer. Saleh *et al.* (2023) found that firms benefit more from proactive and explorative DC than reactive and exploitative utilization. To understand how innovation for knowledge and resource transfer effects DC (e.g. Cordeiro *et al.*, 2023; Ullah *et al.*, 2024), previous studies have largely neglected how IC strengthens

the relationship between DC and innovation outcomes, despite research emphasizing the importance of a firm's strategic orientation. This knowledge is vital because IC offers firms a competitive edge and strategic orientation and enables employees emotionally and structurally to innovate (Newman *et al.*, 2019; Oke *et al.*, 2013; Ye *et al.*, 2022). Therefore, we proposed that a high DC has a greater impact on AI in a high-level IC.

The present study is structured as follows: Section 2 outlines the theoretical framework and hypothesis development. Section 3 details the research methodology. Section 4 presents the results of the hypothesis testing, providing an empirical evaluation of the proposed relationships. Finally, Section 5 discusses the findings, theoretical and practical contributions, study limitations, and suggests directions for future research.

2. Theoretical background and hypothesis development

2.1 Managerial ties, dynamic capabilities and ambidextrous innovation

To attain sustainable innovation, prior studies emphasized that firms must balance and combine exploratory–exploitative innovations concurrently, a concept commonly referred to as ambidexterity (Zhang *et al.*, 2023). The concept of exploitation centers on optimizing efficiency and control, whereas exploration emphasizes the importance of experimentation, which can result in significant gains or losses (He and Wong, 2004; Jansen *et al.*, 2009). Exploration entails a transition toward new knowledge trajectories, whereas exploitation pertains to the acquisition of knowledge through the process of refining, selecting and reusing existing routines, which are built upon existing knowledge bases (He and Wong, 2004; Jansen *et al.*, 2009). The balance facet of AI underscores the importance of balancing exploitation–exploration innovation. When it is close to relative weight, the firm is operating at a high level of BAI. In this situation, it is more beneficial for firms to create knowledge through a balanced configuration of two distinct types of AI. On the contrary, the significant imbalance of exploration-exploitation innovation poses a constraint on new knowledge creation, hence amplifying the survival risk of firms (Jansen *et al.*, 2009; Rojas-Córdova *et al.*, 2023). The fundamental principle behind the concept of CAI posits that exploration–exploitation innovation operates in complementary domains (Jansen *et al.*, 2009). Exploration innovation highlights that firms acquire external knowledge, whereas exploitation innovation centers on internal knowledge processing within firms.

Several bodies of literature contend that the two dimensions of AI are essential and mutually influence the transfer of knowledge and resources. This study posits that there exists a symbiotic relationship of exploration–exploitation innovation, resulting in the creation of leverage effects. Although, scholarly investigations demonstrate the relevance of explorative–exploitative innovations, as well as the criticality of balancing and combining them to attain a resilient and persistent competitive leadership, their coexistence at the organizational level is challenging to maintain (Sun *et al.*, 2022). This is relevant in dynamic industries, such as the energy sector, which faces increasing societal expectations, high costs and increasing regulations, ultimately putting pressure on all energy firms to simultaneously speed up and increase the effectiveness of the clean and renewable energy development process (Shuea*n et al.*, 2014; Truby, 2023).

The utilization of MT has the potential to facilitate the implementation of AI by augmenting the company's ability to actively pursue and acquire new knowledge and resources that surpass the limitations of current experience (Uzkurt *et al.*, 2023). Following resource-based logic, many studies have examined MT as an important antecedent of competitive advantage through innovation (Zhang *et al.*, 2023). MT has frequently been separated into the key resources of BT and PT (Ushie *et al.*, 2023). BT refers to the connections established between firms and strategic business partners, including suppliers, customers, competitors and other market participants that provide access to a diverse variety of valuable resources like as

specialized knowledge, technical expertise, advanced technology and complementary skills (Rawat, 2020; Uzkurt *et al.*, 2023). PT refers to the social networking activities of firms with government bureaucrats, regulatory agencies and financial institutions that provide firms with access to timely information regarding industry development plans, emerging regulatory regulations and innovation initiatives that enable firms to engage in lobbying efforts to influence government policies in their favor (Wang and Liang, 2018; Zhang *et al.*, 2023). Therefore, the key task for firms is to orchestrate DC resources, which can be achieved through deploying MT (Greven *et al.*, 2022). DC refers to the firm's capacity to render firms capable of responding to change, which requires learning, integrating and reconfiguring capabilities (Gupta and Gupta, 2019; Ilmudeen, 2022; Teece, 2018). The deployment of DC is underpinned by the keystone of knowledge and learning (Birkinshaw *et al.*, 2016; Cordeiro *et al.*, 2023; Khaksar *et al.*, 2023). The acquisition and utilization of external knowledge related to DC results in enhanced innovation and organizational performance (Ilmudeen, 2022; Lin and Wu, 2014). Therefore, we propose that the implementation of MT in firms can facilitate the extraction of valuable and novel knowledge from the market, identification of market opportunities, acquisition of essential knowledge and reconfiguration of processes to achieve superior innovation and performance compared to competitors.

Lin *et al.* (2023) contend on the direct impact of MT on innovation, suggesting DC as a mediator. Therefore, high AI cannot be confirmed by MT attributes exclusively. Innovation, in fact, emerges through external knowledge and resource transfer, sharing and recombination, which require the reuse of existing knowledge and capabilities in knowledge-intensive firms (Ju *et al.*, 2023). It has been extensively debated that MT does not directly result in AI, but rather undergoes a transformation into organizational capabilities, enabling firms to effectively address market demands (Wilden *et al.*, 2018). In the context of DC, innovation necessitates the presence of codified knowledge that is effectively disseminated within a firm. The key importance of MT within the DC perspective is evident because a significant portion of the literature in the field focuses on changing behavior, as well as building and reconfiguration both internal and external competencies (Shuen *et al.*, 2014). The main hurdle in building DC includes changing available organizational resources and knowledge base, as well as human capital and the routines and processes of the firm (Stefano *et al.*, 2014; van Lieshout *et al.*, 2021). Therefore, it is contended that the relation between MT and AI progresses via DC. Prior research suggested that DC enhances firms' ability to effectively convert knowledge and resources into AI. In view of that, we propose the following hypotheses:

H1. DC mediates the relationship between MT and AI.

H1a. DC mediates the relationship between BT and BAI.

H1b. DC mediates the relationship between BT and CAI.

H1c. DC mediates the relationship between PT and BAI.

H1d. DC mediates the relationship between PT and CAI.

2.2 Innovation climate as moderator for dynamic capabilities and ambidextrous innovation

The concept of IC was defined as the contextual framework that facilitates the ongoing process of innovation within organizations (Scott and Bruce, 1994). In accordance with Amabile (1988), the implementation of IC offers the potential to effectively foster the creative behaviors exhibited by individuals inside a firm. These creative behaviors, in turn, act as a catalyst for the process of AI. According to Newman *et al.* (2019), a firm with a robust IC is more inclined to encourage its members to engage in boundary-spanning activities, hence facilitating the exploration of external knowledge and resources. Furthermore, the alignment with proactive growth-oriented initiatives and the adoption of positive innovation norms are

essential factors not only in facilitating the delivery of innovation but also in ensuring the long-term viability of an innovative firm. IC promotes the dissemination, conversion and assimilation of existing knowledge within firms. Therefore, it enhances the capacity of organizations to both proactively seek external knowledge and effectively use internal knowledge. Overall, the significant function of IC as a situational facilitator may be supported based on several aspects. According to Rojas-Córdova *et al.* (2023), firms operating within a competitive market must engage in both exploratory innovation, which enhances the likelihood of technological breakthroughs and exploitative innovation, which facilitates the accumulation of knowledge and capacities. A significant level of knowledge capability enhances the organization's capacity to recognize and generate opportunities through its behaviors and actions. To capitalize on these opportunities, firms endeavor to cultivate novel competencies that enable them to proactively engage with external knowledge and resources, while simultaneously leveraging their internal knowledge and resources to reconfigure their processes and structures (Thai *et al.*, 2024; Zhang *et al.*, 2022). The concept of IC encompasses a learning philosophy that fosters a collective mindset toward learning. It also governs and guides all operational competencies necessary for fostering innovation (Siguaw *et al.*, 2006). A firm with a stronger IC possesses a more comprehensive belief system that facilitates innovation by unifying and directing processes and practices. These organizations demonstrate a proactive approach to acquiring and using novel knowledge to drive innovation, hence enhancing their competitiveness in the development and utilization of specific resources (He and Sun, 2023). IC fosters the cultivation of collaborative relationships with external partners. This approach is particularly advantageous due to the recognition that valuable information and capabilities required for innovation frequently reside beyond the boundaries of the firm (Maalouf and Bahemia, 2023). IC plays a crucial role in enabling organizations to foster an environment conducive to the generation and dissemination of novel ideas pertaining to technologies, processes, goods and services (Zhang *et al.*, 2022). Hence, IC encourages proactivity and innovative initiatives that effectively guide and align the capabilities of the firm toward a culture of innovation and creativity, ultimately resulting in improved organizational innovation performance. Furthermore, for firms characterized by a significant level of IC, DC is highly suitable for making valuable contributions to the field of AI. Based on the aforementioned considerations, we put forth the following proposition:

H2. IC moderates the relationship between DC and AI. Therefore, DC have a greater positive impact on AI in organizations with higher levels of IC.

H2a. IC moderates the relationship between DC and BAI. Therefore, DC have a greater positive impact on BAI in organizations with higher levels of IC.

H2b. IC moderates the relationship between DC and CAI. Therefore, DC have a greater positive impact on CAI in organizations with higher levels of IC.

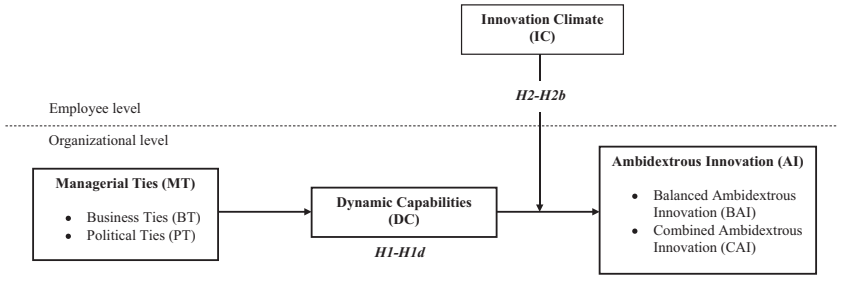
Figure 1 shows the research model of our study.

3. Research methodology

3.1 Sampling and data collection

To analyze our model, we collected data using an online survey targeting energy firms within the United Arab Emirates. Energy firms play a crucial role in the global economy through their engagement in research, development and dissemination of sustainable and innovative energy solutions. Prior studies have emphasized the relevance of examining the energy industry in relation to DC-related research (Cordeiro *et al.*, 2023; González-Ramos *et al.*, 2023). This is due to the fact that energy firms are recognized as knowledge-intensive organizations that heavily rely on knowledge-intensive activities (Zhao *et al.*, 2023), and frequently engaged in exploratory–exploitative innovation transitions (Kolte *et al.*, 2023). The data were acquired from energy firms listed in the UAE Ministry of Energy and Infrastructure. The UAE is implementing

Figure 1 Research model



Source: Developed by authors

innovative measures in the field of renewable energy and energy efficiency. The Net Zero by 2050 Strategic Initiative of the UAE aligns with the objectives of the Paris Agreement and is in line with the UAE's development strategy of fostering new knowledge and promoting sustainable industries (Kilinc-Ata and Alshami, 2023). In addition, the UAE Energy Strategy 2050 outlines the imperative of renewable and sustainable energy to effectively address economic and environmental goals (Truby, 2023). In light of this recognition, the UAE Government has developed a range of incentives, policies promoting sustainable energy and tight regulations aimed at fostering the beneficial outcomes of advanced sustainable energy innovation efforts. Consequently, the UAE has played a pivotal role in spearheading global endeavors to embrace sustainability and enhance the utilization of renewable energy sources. In this regard, energy firms have emerged as crucial strategic instruments, facilitating the integration and implementation of cutting-edge sustainable energy innovation initiatives within their strategic frameworks and operational activities (González-Ramos *et al.*, 2023). Furthermore, BT and PT in the UAE are generally recognized for their significant impact on firms' operations, as they facilitate the synchronization of knowledge and technological resources. Hence, the UAE represents a sufficient empirical context for this research, which centers on examining the impact of MT consisting of BT and PT on AI dimensions of BAI and CAI with a specific focus on the mediating role of DC and the moderating effect of IC.

Before conducting the survey, the instrument underwent a rigorous pretesting process, which involved conducting a series of in-depth interviews with four senior managers with 20 years of experience. The purpose of these interviews was to ensure the content, clarity and wording of the statements in the survey instrument were accurate and appropriate (Buschle *et al.*, 2022). To conduct a more comprehensive assessment of content validity, two professor experts in innovation and strategic management fields were enlisted to scrutinize the measuring scales for any potential issues. Following the refinement of the questionnaire, a total of 47 UAE renewable energy firms agreed to participate in this study. Specifically, six main activities were considered, including energy generation; manufacturing of technological components; marketing and export of components; engineering activities; energy consulting; and installation and maintenance activities. Therefore, the following sampling criteria were applied:

- Firms possess robust networks and cultivate close rapport to gain access to external knowledge and resources in renewable and sustainable energy context.
- Firms use extensive innovation as a result of technology- and knowledge-driven emphasis on continuous development.
- Firms encounter intense competition and substantial unpredictability, prompting them to proactively generate novel knowledge and resources to effectively address challenges and capitalize on emerging prospects.

The aforementioned factors, in conjunction with the significance of renewable energies in attaining sustainable development, as well as the attention and influence of these endeavors in relation to social welfare advantages, prompted us to choose this sector as a conducive setting for our research. To mitigate concerns of common method bias we did not rely on a single source to collect the data but rather collected the independent and control variables from senior managers, and the dependent variable from R&D managers. To control cross-sectional bias, the two surveys were conducted at two different times (Podsakoff *et al.*, 2012). At T1, senior managers were requested to provide data regarding the firm's age and size, as well as information on BT, PT and DC. IC was assessed by requesting employees to indicate the level of IC within the firm. The study's objective was clarified, and any inquiries or issues presented by senior managers of each renewable energy firm were addressed. Only senior managers who agreed to participate were given the survey questionnaire bundle and instructions. Each bundle included one questionnaire for senior managers and ten questions for employees, each with corresponding coded envelopes. The senior managers were instructed to deliver the employee surveys after they finished completing their questionnaires. Questionnaires were only sent to employees who volunteered to participate. They were required to place their answers in the designated envelope, seal them to maintain confidentiality and then deposit the envelope in the collecting box provided by the researcher. At this stage, 300 employees have consented to participate in the survey. Three months after the completion of the surveys, the senior managers agreed to arrange a meeting between the researchers and their R&D managers. At T2, R&D managers were requested to provide relevant data on AI for their respective firms. The researcher approached R&D managers from participating firms to explain the study's purpose and address any questions or concerns they had. Only the R&D managers who were willing to participate were given the survey questionnaire. At this stage, 168 R&D managers have volunteered to participate in the study. The final sample consists of 164 senior managers, 151 R&D managers and 288 employees after removing the questionnaire with incomplete data. This represents a response rate of 53.3%.

Among 288 employees, majority were male (184, 63.9%), age between 36 and 45 (170, 59.0%), experience (in years) between 10 and 20 (189, 65.6%) and have master's degree (116, 40.3%). In total, 23 firms had 11–20 years of experience (48.9%) and 16 firms with size ranged from 351 to 500 employees (34.0%).

3.2 Measures

All the constructs were measured by adapting predeveloped measurement scales on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). All constructs except for IC were measured as a second-order construct. We used 12 items from Jansen *et al.* (2006) and Chang and Hughes (2012) to investigate AI. Following He and Wong (2004), BAI was calculated used seven minus the absolute difference and CAI were evaluated is calculated by the product of the two. In addition, 8 items from Sheng *et al.* (2011) to assess MT and 11 items from Lin and Wu (2014) to measure DC and four-item scale from Oke *et al.* (2013), Scott and Bruce (1994) and Hoang *et al.* (2019) to measure IC.

Firm-level IC scores were obtained by averaging the IC scores of employees who participated in the study. To justify the aggregation, within-group homogeneity and between-group heterogeneity were tested. The results of one-way analysis of variance showed that IC differed ($p < 0.000$) between firms. The intraclass correlation coefficients were $ICC_1 = 0.49$ and $ICC_2 = 0.87$. Furthermore, mean rwg score was used to explain individual-level data aggregation above the cutoff score of 0.70, indicating adequate within-organization agreement (Bliese *et al.*, 2020). Table 1 shows all variables and the corresponding measures.

Table 1 Confirmatory factor analysis of hypothesized six-factor model

Construct/items	*Factor loadings*
Ambidextrous innovation (AI) ($\alpha = 0.76$, AVE = 0.60, CR = 0.95)	
Exploratory innovation ($\alpha = 0.76$, AVE = 0.58, CR = 0.89	
Our firm accepts demands that go beyond existing products and services	0.795
We invent new products and services	0.777
We experiment with new products and services in our local market	0.776
We commercialize products and services that are completely new to our firm	0.782
We frequently use new opportunities in new markets	0.772
Our firm regularly uses new distribution channels	0.680
Exploitative innovation ($\alpha = 0.78$, AVE = 0.61, CR = 0.90)	
We frequently refine the provision of existing products and services	0.852
We regularly implement small adaptations to existing products and services	0.733
We improve our provision's efficiency of products and services	0.787
We increase economies of scales in existing markets	0.798
Our firm expands services for existing clients	0.649
Lowering costs of internal processes is an important objective	0.838
Managerial ties (MT) ($\alpha = 0.75$, AVE = 0.57, CR = 0.91)	
Business ties (BT) ($\alpha = 0.76$, AVE = 0.58, CR = 0.87)	
Supplier firms	0.795
Customer firms	0.791
Competitor firms	0.673
Marketing-based collaborators	0.857
Technological collaborators	0.671
Political ties (PT) ($\alpha = 0.74$ AVE = 0.54, CR = 0.78)	
Top managers at our firm have maintained good personal relationships with officials in various levels of government	0.795
So far, our firm's relationship with regional government officials has been in a good shape	0.681
Our firm has spent substantial resources in building relationships with government officials	0.732
Dynamic capabilities (DC) ($\alpha = 0.79$, AVE = 0.63, CR = 0.95)	
Learning capability ($\alpha = 0.80$, AVE = 0.64, CR = 0.87)	
We are constantly learning within the firm	0.735
In our firm, the process of knowledge creation and development takes place according to the requirements of the units	0.825
We are constantly setting up training teams	0.849
We have ongoing cross-department training programs	0.786
Integrating capability ($\alpha = 0.79$, AVE = 0.62, CR = 0.83)	
Our firm focuses on gathering customer information and discovering potential markets	0.786
Our firm uses the specialized services of other organizations in its management decisions	0.778
Our firm focuses on technologies related to the renewal energy to develop new products	0.791
Reconfiguration capability ($\alpha = 0.79$, AVE = 0.63, CR = 0.87)	
Our firm focuses on reorganizing jobs and creating new job opportunities	0.761
Our firm reacts quickly to market changes	0.808
Our firm responds to its competitors in a timely manner	0.790
We have effective and efficient communication with partner firms	0.806
Innovation climate (IC) ($\alpha = 0.71$, AVE = 0.53, CR = 0.81)	
In my firm, the supervisor supports their team in the unit or department to which they belong	0.895
Employees in my firm can easily obtain the resources they need for their jobs	0.819
In my firm, communication within the team is free and open	0.801
In my firm, innovation will be rewarded	0.863

Note: All loadings are significant at $p < 0.001$
Source: Developed by authors

3.3 Data validation and measurement model

We examined the systematic differences in participants between the two phases of data collection by comparing the first half and the final half of the sample (Goodman and Blum, 1996). The results indicated no significant difference between respondents and nonrespondents at T1 and T2, indicating that attrition did not seriously affect our findings. Furthermore, the

variance inflation factors used to assess multicollinearity yielded values below 5.0, suggesting the absence of multicollinearity in the present investigation.

Confirmatory factor analysis was conducted to test the fitness of measurement model and construct distinctiveness (Podsakoff *et al.*, 2012). The results demonstrated that the six-factor model (Model 5) fits the data better when compared with alternative models (see Table 2), providing support for the discriminant validity of the study variables. Next, we checked the convergent validity by assessing the composite reliability (CR) and average variance extracted (AVE) scores as recommended by Hair *et al.* (2020). We found that the CR and AVE scores of each construct were greater than the cutoff value of 0.70 and 0.50, respectively (see Table 1). These results revealed that each construct has a satisfactory level of convergent validity. Furthermore, according to Fornell and Larcker (1981), discriminant validity can be assessed by comparing the AVEs of the constructs were compared to their corresponding squared correlations. Table 2 shows square roots of the AVE values exceeded the correlation coefficients between all variables. Moreover, the heterotrait–monotrait (HTMT) ratio of constructs was below 0.85 cutoff, indicating sufficient discriminant validity between variables (Henseler *et al.*, 2015).

4. Hypotheses testing

To test our hypotheses, multilevel analysis was conducted using AMOS 26. The results (see Table 3) revealed significant and positive direct effects between MT and AI ($\beta = 0.68$, $p < 0.001$), BT ($\beta = 0.26$, $p < 0.05$) on BAI, BT ($\beta = 0.40$, $p < 0.001$) and PT ($\beta = 0.28$, $p < 0.01$) on CAI, and MT ($\beta = 0.38$, $p < 0.001$), BT ($\beta = 0.25$, $p < 0.05$) and PT ($\beta = 0.27$, $p < 0.01$) on DC. However, the relationship between PT ($\beta = 0.05$, $p > 0.05$) and BAI was found insignificant.

Similarly, DC found to mediate the relationship between BT and BAI ($\beta = 0.15$, $p < 0.01$; *H1a* was supported), and CAI ($\beta = 0.15$, $p < 0.01$; *H1b* was supported). Furthermore, DC mediated the relationship between PT and CAI ($\beta = 0.16$, $p < 0.01$), supporting *H1d*. However, DC was found not mediated the relationship between MT and AI ($\beta = 0.10$, $p > 0.05$; *H1* was not supported), and PT and BAI ($\beta = 0.19$, $p > 0.05$; *H1c* was not supported). Finally, the moderating effect of IC was tested between DC and AI ($\beta = 0.23$, $p < 0.001$), BAI ($\beta = 0.12$, $p < 0.001$) and CAI ($\beta = 0.25$, $p < 0.001$), supporting *H2*, *H2a* and *H2b* (see Figure 2).

5. Discussion and contributions

Drawing on the DC perspective, this study offers insight into the dynamic framework between MT and AI in the energy sector, using DC as a mediator and IC as a moderator mechanism. The results reveal that DC has a significant mediating influence on BT and BAI, BT and CAI and PT and CAI relationships. Regarding the moderation effects, IC is a significant moderator between DC and AI and BAI and CAI, with a higher indirect effect on CAI than BAI. Contrary to hypothesized relationships, our results revealed no significant mediation effect of DC between MT and AI or PT and BAI. These findings contradict Lin *et al.*'s (2023) and Wilden *et al.*'s (2018) research, which identified DC as a key mediator between MT and AI. In other words, energy sector managers may be struggling to improve their DC in these relationships due to the type and strength of PT, temporal factors due to the effects of PT, the evolving effect of DC and BAI over time, and contextual factors such as industry, geographic location and the specific characteristics of energy firms. These notions are consistent with Cordeiro *et al.* (2023), who propose that environmental dynamism influences the relationship between MT-DC and AI, as well as PT-DC and BAI. Furthermore, DC literature demonstrates that the role of DC as a mediator may be enhanced by a multitude of contextual factors, including industry, organizational culture, leadership and the specific nature of MT and DC (Khaksar *et al.*, 2023; Li *et al.*, 2023; Ruiz-Ortega *et al.*, 2023). The moderating results of IC demonstrate the role of employees'

Table 2 Measurement model of studied variables

Variables	*Mean*	SD	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1. Firm age	3.36	0.90								
2. Firm size	3.48	1.25	0.19*							
3. Business ties	6.32	0.81	0.05	0.03	*0.76*					
4. Political ties	6.42	0.84	0.07	0.07	0.68*** (0.53)	*0.73*				
5. Dynamic capabilities	6.21	0.86	0.02	0.03	0.66*** (0.50)	0.64*** (0.57)	*0.79*			
6. Innovation climate	6.16	0.91	0.13	0.09	0.60*** (0.47)	0.58*** (0.49)	0.56*** (0.52)	*0.73*		
7. Exploratory innovation	6.39	0.76	0.12	0.12	0.59*** (0.44)	0.56*** (0.47)	0.58*** (0.49)	0.58*** (0.48)	*0.76*	
8. Exploitative innovation	6.54	0.65	0.06	0.04	0.61*** (0.51)	0.61*** (0.53)	0.57*** (0.48)	0.57*** (0.47)	0.61*** (0.55)	*0.77*

Model fit summary
(Model 1) One-factor: $\chi^2 = 3678$, df = 560, $p = 0.000$, CFI = 0.68, TLI = 0.68, RMSEA = 0.139, SRMR = 0.08
(Model 2) Four-factor model: $\chi^2 = 2613$, df = 554, $p = 0.000$, CFI = 0.79, TLI = 0.77, RMSEA = 0.11, SRMR = 0.06
(Model 3) Five-factor model: $\chi^2 = 2237$, df = 550, $p = 0.000$, CFI = 0.83, TLI = 0.82, RMSEA = 0.10, SRMR = 0.06
(Model 4) Five-factor model: $\chi^2 = 2569$, df = 550, $p = 0.000$, CFI = 0.80, TLI = 0.78, RMSEA = 0.11, SRMR = 0.06
(Model 5) Six-factor model: $\chi^2 = 2068$, df = 512, $p = 0.000$, CFI = 0.94, TLI = 0.92, RMSEA = 0.03, SRMR = 0.04

Notes: $N = 288$; $^{*}p < 0.05$; $^{***}p < 0.001$; Italic numbers on the diagonal show the square-roots of AVE. HTMT ratios are in parentheses. Model 1: All variables combined, Model 2: Managerial ties + Dynamic capabilities + Innovative climate + Ambidextrous innovation, Model 3: Managerial ties + Dynamic capabilities + Innovative climate + Exploratory innovation + Exploitation innovation, Model 4: Business ties + Political ties + Dynamic capabilities + Innovative climate + Ambidextrous innovation, Model 5: Business ties + Political ties + Dynamic capabilities + Innovative climate + Exploratory innovation + Exploitation innovation
Source: Developed by authors

Table 3 Results of hypotheses testing

Hypotheses	*Path*	*Estimate*	*SE*	*Lower and upper 95% CI limits*	*Results*
Test of mediation effects					
H1	MT → DC → AI	0.10	0.10	−0.10, 0.31	Rejected
H1a	BT → DC → BAI	0.15**	0.06	0.03, 0.27	Accepted
H1b	BT → DC → CAI	0.14**	0.05	0.16, 0.35	Accepted
H1c	PT → DC → BAI	0.19	0.11	−0.01, 0.42	Rejected
H1d	PT → DC → CAI	0.16**	0.04	0.02, 0.25	Accepted
Test of moderation effects					
H2	DC*IC → AI	0.23***	0.03	0.16, 0.30	Accepted
H2a	DC*IC → BAI	0.12**	0.04	0.04, 0.20	Accepted
H2b	DC*IC → CAI	0.30***	0.04	0.22, 0.38	Accepted

Notes: $N = 288$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$
Source: Developed by authors

perceptions of IC in leveraging DC mechanisms on AI, BAI and CAI, with a higher influence on BAI than CAI. The importance of learning, integrating and reconfiguration processes for enhancing an energy firm's AI is a well-known area of research (Cordeiro *et al.*, 2023). A stronger IC is more likely to foster creativity, experimentation and a culture of balancing and combining exploratory–exploitative innovation because DC uses the existing capabilities to extract new ones by adapting, changing and innovating (Mendes *et al.*, 2023).

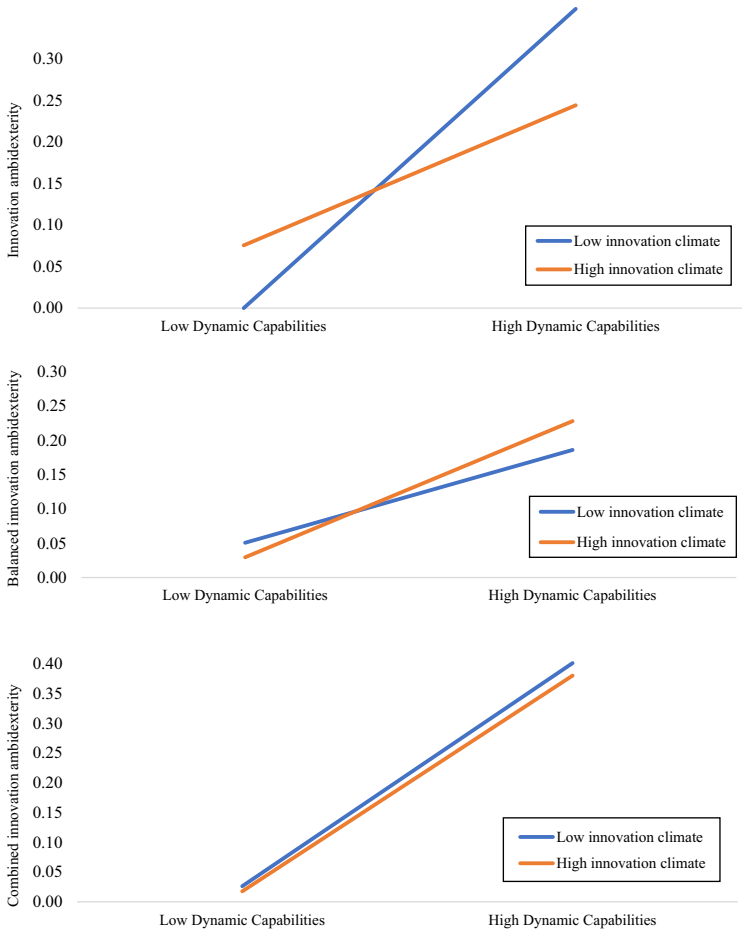
5.1 Theoretical contributions

The study contributes to the current body of knowledge as follows: First, research on the effect of MT, DC and IC on AI has primarily focused on individuals' perceptions of their ability to learn from outside the firm and combine new knowledge and resources with existing ones (e.g. Gao and Sarwar, 2022; Guo *et al.*, 2020; Ilmudeen, 2022; Zhang *et al.*, 2022), with the goal of better understanding how the complex and multilevel phenomenon of MT, DC and IC affects exploration-exploitation innovation (Brennecke *et al.*, 2016; Chen *et al.*, 2023; Luo, 2002). This is a significant gap in knowledge because MT, DC and IC are critical for individual and firm innovation efforts. Our findings demonstrated that BT and PT have a positive effect on DC, which leads to BAI and CAI, whereas IC strengthens these relationships. Our multilevel research approach further contributes to the innovation literature by offering a more fine-grained, supervisor–subordinate interaction perspective, which is currently limited in the literature (Wang *et al.*, 2023a, 2023b). As a result, our study demonstrates how a multilevel approach allows us to gain a more comprehensive understanding of how MT, DC and IC foster AI.

Second, we found that DC plays a mediating role in the link between MT, its dimensions and AI outcomes. As a result, this study responds to Dean's (2021) call for more DC-ambidexterity-related research by examining how MT would increase firms' DC, thereby fostering BAI and CAI. We contribute to the DC literature because the majority of existing studies have focused on employee-level DC antecedents, and DC and AI have not been examined together with organizational-level MT. This is consistent with Wang *et al.* (2023a, 2023b) suggestion to research multilevel, antecedent-focused research on DC.

Third, by considering AI to have a distinct influence from its distinct components and their combined impacts, as well as investigating DC as a vital mechanism linking MT and AI and IC as an important boundary condition between DC and AI, our research advances the ambidexterity literature. Our findings show that when employees strongly perceive that managers support creativity and innovation in their organizational environment, including factors that encourage creativity, autonomy, freedom, resources and pressure, as well as barriers to creativity, their managers have the experience and skills to use boundary-spanning activities, including knowledge and interactions with other external entities, business and politics, to foster

Figure 2 Moderating effect of innovation climate on the relationship between dynamic capabilities and ambidextrous innovation, balanced ambidextrous innovation and combined ambidextrous innovation



Sources: Developed by authors

the firm's ability to integrate, build and reconfigure internal and external resources and competences to address and shape the rapidly changing business environment and influence firms' exploration-exploitation activities. Our results help us understand the important but unstudied boundary condition and intervening mechanisms that link MT to AI by showing the mediating role of DC and the moderating role of IC.

Finally, our study is one of the few to investigate the impact of DC on AI in the energy sector. This is supported by recent literature, which indicates that DC contributes to AI planning in dynamic and sustainable energy firms (Cordeiro *et al.*, 2023; González-Ramos *et al.*, 2023). As a result, our study responds to Cordeiro *et al.*'s (2023) and González-Ramos *et al.*'s (2023) demand for research into the role of MT in the energy environment.

5.2 Managerial implications

The current study has important consequences for HR practitioners, policymakers and academics. It emphasizes the importance of MT and DC, how they fit into the demanding

and dynamic innovation environment of the energy sector and how they improve exploration–exploitation outcomes. As the energy industry faces challenges from frequent regulatory and technological shifts (Srisathan *et al.*, 2023; Uzkurt *et al.*, 2023), HR practitioners must address these by developing the competencies required to effectively acquire and assimilate external knowledge, integrate it with their existing knowledge base and adapt to external changes (Zhao *et al.*, 2023). In this context and considering the positive impact that MT and DC have in shaping AI results, energy industry leaders are encouraged to foster and support MT activities and interactions with other businesses and government agencies. This can be accomplished with adequate training and instruction. Furthermore, HR practitioners may need to reevaluate their recruitment strategy, which involves prioritizing hiring managers with both BT and PT. Furthermore, energy managers must foster networking thinking to cope with interactions that facilitate exploration and exploitation to the benefit of both firms and employees. Similarly, these managers must serve as role models and encourage their employees to embrace AI objectives and act innovatively.

According to Ochie *et al.* (2022), energy managers anticipate an integrated focus on leveraging their enlarged knowledge and resource base for AI. Because each firm, regulator and stakeholder has unique needs, policymakers can help encourage their participation as the energy sector rapidly transforms in response to changing market dynamics (Cordeiro *et al.*, 2023). González-Ramos *et al.* (2023) posit that energy firms play an important role in leading the cutting-edge research, development and delivery of innovative renewable and sustainable energy solutions to society. However, policymakers should provide a conducive environment for the adoption of renewable systems and emerging technologies to establish a long-term and sustainable energy consumption pattern, which has become more important for both developed and developing countries over the last two decades. Furthermore, policymakers must reevaluate their policy strategy, which requires energy firms to significantly broaden their management teams to properly respond to regulatory and technological changes in a timely fashion. Furthermore, policymakers must support sustainable and renewable energy activities by incentivizing firms to implement measures to increase energy efficiency and productivity and reduce emissions. As a result, there is an increasing expectation that this sector will actively contribute to societal well-being by encouraging continuous innovation.

Furthermore, academics can collaborate with energy managers to help energy firms improve their ability to obtain knowledge from external markets, integrate their resources and adapt to stimulate innovation. Intangible assets generated by academicians through R&D and consultation activities require energy firms to obtain critical market knowledge and insights to seek opportunities for investment in intellectual assets. As a result, energy managers can strengthen MT in their firms by engaging in innovation activities with academics to proactively address societal expectations by delivering unique products, services, processes and technology in comparison to their competitors.

5.3 Limitations and future research

This study includes several limitations that must be addressed. First, this study investigated the effects of MT on AI employing balanced-combined dimensions. Future research ought to investigate how MT influences knowledge-sharing and knowledge-hiding behaviors to provide insights into how firms may efficiently manage exploratory and exploitative activities. Second, while there was no common method bias, IC was evaluated based on employee perceptions. As a result, future research should consider assessing IC using supervisor ratings, as supervisor ratings can provide a more consistent and standardized assessment of the firm's IC than employee ratings, which can vary depending on factors such as job role, department or personal experiences, resulting in inconsistent results. Third, because DC was viewed as a single construct, future research may investigate its dimensions – learning, integrating and

reconfiguration capabilities – for better insights. By assessing all three dimensions of DC, future studies can gain a more comprehensive understanding of how energy firms build and leverage their capabilities to respond to environmental changes. Each factor contributes uniquely to the energy firm's ability to innovate and adapt. Finally, future studies should examine the role of the employee paradox mindset, which has been shown to influence employee innovativeness (Al Hasan and Micheli, 2022). Exploring this topic could shed light on how employees balance exploration and exploitation (Klein *et al.*, 2024), emphasizing the relevance of employee-level factors in defining DC.

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