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Exploration–Exploitation: How business analytics powers organisational ambidexterity for environmental sustainability

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Abstract

Simultaneous exploration and exploitation (i.e., exploration–exploitation) can help a firm address short-term environmental requirements and ensure long-term environmental viability. Exploration–exploitation, however, challenges organisational practices because they compete for resources and time. While business analytics (BA) offers the potential to overcome these challenges, research to date offers very limited insights into how BA capabilities interact with ambidextrous capabilities to realise environmental value. We address this issue by conducting a comparative case study at a bank and at a real-estate trust through the theoretical lens of dynamic capabilities. We develop a process model to explain how BA powers ambidextrous practices to achieve sustainability outcomes over time. We uncover two mechanisms: a *BA-powered context shaping* mechanism by which BA powers contextual ambidexterity at the employee level using data availability, timeliness, and analytics culture; and a *BA-powered resource linking* mechanism by which BA powers structural ambidexterity at intra- and inter-organisational levels using holistic insights and analytics leadership. Our model highlights the contextual factors that condition the extent to which a firm moves along the continuum of exploration–exploitation. We also define a

new dimension of sustainability outcomes which we label eco-awareness to explain how BA shapes employees' environmental alertness and enables the paradigm shift in an organisation's sustainability mindset.

KEYWORDS
business analytics, comparative case study, eco-awareness, environmental sustainability, exploration–exploitation, organisational ambidexterity

1 | INTRODUCTION

Environmental sustainability is becoming increasingly urgent and important. As an example, a new term 'climate emergency' was declared the Oxford Dictionary's word of the year in 2019, calling for attention and actions to reduce climate change (Rice, 2019). To solve urgent environmental issues, organisations should use sustainability as a source of competitive advantage, rather than treating it as nice-to-have (Balta et al., 2020). If used effectively, sustainability can help a firm avoid the risks of not complying with regulations and grasp opportunities to win investors and customers (Eccles & Klimenko, 2019). The key is to understand how to develop sustainability practices to generate environmental value operationally, strategically, and even culturally (Loeser et al., 2017; Watson et al., 2010).

Environmental sustainability requires organisational practices that ensure the environmental well-being of the current generation as well as the prosperity of future generations (Elliot, 2011; World Commission on Environment and Development, 1987). To do so, firms need a both/and mindset to explore sustainability innovation to prosper while exploiting existing resources to survive (March, 1991; Vessey & Ward, 2013). Simultaneous exploration and exploitation are presented in the notion of 'exploration–exploitation' (Lavie et al., 2010, p. 110), the core of organisational ambidexterity. Exploration–exploitation emphasises that, instead of pursuing one over another, a firm moves along the continuum between two ends as the activities reinforce each other in a virtuous cycle (Andriopoulos & Lewis, 2009; O'Reilly III & Tushman, 2013). However, driven by different foci, exploration and exploitation activities compete for the limited resources and time of a firm (O'Reilly III & Tushman, 2008). Existing research has not shed light on how to overcome the limitations to realise the full potential of exploration–exploitation for environmental sustainability, especially from an information systems (IS) perspective.

Big data offer unprecedented opportunities for firms to access resources and obtain timely information to solve environmental issues (Barnes et al., 2022; Pappas et al., 2018). To harness the power of big data, firms develop business analytics (BA) capabilities (i.e., the abilities to transform data into actional insights) for sustainability decision-making (Seddon et al., 2017). For example, by using smart-metre data organisations can adjust their energy consumption timely and with lower labour costs (Gholami et al., 2016). BA capabilities, therefore, offer the potential to augment organisational ambidexterity through the use of big data. However, existing research largely focusses on the economic value of BA (Seddon et al., 2017; Sharma et al., 2014). There has not been an in-depth investigation into how BA helps a firm explore–exploit environmental knowledge for sustainability.

This research examines the research question: *How does a firm use BA to power ambidexterity to achieve environmental sustainability over time?* To answer the question, we conducted a comparative case study across two firms: a bank (i.e., BankEx) and a real-estate trust (i.e., GPT). Because our early-stage data showed that ecosystem-wide collaboration is essential to each case firm's sustainability activities, we further collected data from the BA software vendor (i.e., Envizi-an IBM company) and the consultancy firm (i.e., Energetics) of BankEx and GPT. The ecosystem-wide data enabled us to comprehensively understand the sustainability practices at both case firms.

This research draws on dynamic capabilities theory, particularly its notion of complementarity and evolutionary fitness (Teece, 2007; Teece et al., 1997), to develop a theoretical model of BA-powered ambidexterity for environmental sustainability. Using complementarity, the model suggests that the sustainability value of organisational ambidexterity is augmented in the presence of BA capabilities. Using evolutionary fitness, it posits a dynamic process where BA-powered ambidextrous practices continuously adapt to changes to realise eco-efficiency, eco-effectiveness, and eco-awareness. The model explicates two mechanisms that underlie BA-powered ambidextrous practices. Via the *context shaping* mechanism, BA fosters an organisational context that allows employees to flexibly align with and adapt to sustainability requirements at the same time. Via the *resource linking* mechanism, BA facilitates intra- and inter-organisational collaboration for firms to explore–exploit environmental knowledge. The comparative case analysis highlights the contextual factors (i.e., environmental dynamism; organisational identity; ecosystem-wide collaboration) that enable firms to undertake sustainability activities differently.

Our research makes unique, important contributions in three aspects. First, prior research highlights the paucity of understanding IS-based capabilities for sustainability (Cooper & Molla, 2017; Elliot & Webster, 2017). This research examines a particular IS capability (i.e., BA) and theorises two mechanisms (i.e., context shaping; resource linking) to explain how BA augments organisations' existing capabilities to achieve sustainability outcomes over time. Second, existing literature largely focusses on the economic value of BA. This research advances the BA value realisation literature by examining its environmental value (Barnes et al., 2022; Pappas et al., 2018). It suggests data availability, timeliness, and culture power exploration–exploitation at the employee level by shaping an ambidextrous context, and holistic insights and analytics leadership power exploration–exploitation at the intra- and inter-organisational levels by integrating resources. Third, existing research focusses on sustainability outcomes such as eco-effectiveness and eco-efficiency (Watson et al., 2010). Our research defines and explains eco-awareness, a sustainability outcome embedded in organisational culture. Eco-awareness highlights that BA-powered environmental alertness for behaviour changes can result in a paradigm shift in an organisation's sustainability mindset.

We structure the remainder of the paper as follows. We review relevant literature streams in Section 2, followed by the theoretical foundation in Section 3. We present our research design in Section 4. In Section 5, we explain our research findings supported by within- and cross-case analysis, followed by a process model of BA-powered exploration–exploitation for environmental sustainability in Section 6. In Section 7, we present the implications of our research and opportunities for future research, followed by a concluding summary of this research in Section 8.

2 | LITERATURE REVIEW

This research builds on two premises. First, to achieve environmental sustainability, a firm needs to be ambidextrous in simultaneously exploring and exploiting sustainability knowledge. Second, to augment its environmental ambidexterity, a firm needs to use BA capabilities to harness the power of big data for environmental decision-making. Our study, therefore, integrates three streams of literature: environmental sustainability, organisational ambidexterity, and business analytics, as shown in Figure 1.

2.1 | Environmental sustainability in information systems

Information systems (IS) sustainability research emerges from the intersection of sustainability and IS with a focus on how technologies help individuals and organisations develop environmentally responsible behaviours (Seidel et al., 2013; Zampou et al., 2022). To obtain an overview of existing IS research on sustainability, we reviewed empirical studies published in the Senior Scholars' List of Premier Journals. We used the key words "green IS", "green IT", "digital sustainability", "environmental sustainability", "sustainability", and "sustainable information systems" to search relevant articles and screened 20 empirical papers. Appendix 1 summarises the key findings of these studies.

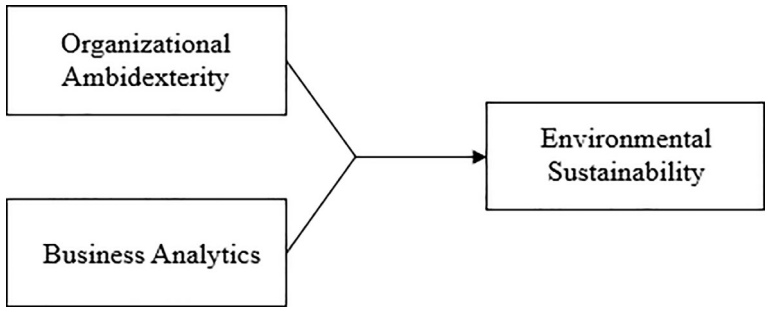

FIGURE 1 Framework of integrating the literature on environmental sustainability, organisational ambidexterity and business analytics.

Overall, the IS sustainability literature has two streams: green IT and green IS. Green IT literature focusses on minimising the negative environmental impacts of technology artefacts, including the design, use and implementation of these artefacts (Fridgen et al., 2016; Seidel et al., 2018). Green IS literature focusses on how technology, people, and processes influence organisations' practices and strategies for sustainability (Loeser et al., 2017; Seidel et al., 2013). Our research aligns with the green IS literature and addresses the following three issues.

First, we demand an understanding of how IS capabilities can work with organisational capabilities to support environmental sustainability practices (Cooper & Molla, 2017). Sustainability requires firms to conduct business activities to meet their current environmental requirements as well as to drive and adapt to sustainability changes in the future. This requires specific capabilities that enable them to simultaneously exploit existing processes while exploring new opportunities for sustainability innovation. Existing research, however, offers insufficient knowledge about how IS interact with organisational capabilities for sustainability exploitation and exploration.

Of the 20 empirical studies identified, four studies explain IS-based capabilities for sustainability. Two studies focus on the impacts of IS capabilities on environmental sustainability including IT capabilities that influence environmental strategy (Benitez-Amado & Walczuch, 2012) and big data analytics capabilities for environmentally sustainable performance (Zhang et al., 2022). Two studies examine IS-enabled organisational capabilities for sustainability, including IS-environmental absorptive capacity and its antecedents and outcomes (Cooper & Molla, 2017), and IS-enabled sense-making, decision-making, and knowledge-creation capabilities for designing and manufacturing environmentally responsible products (Butler, 2011).

Different from prior studies, our research focusses on the complementarity between a particular IS capability (i.e., BA) and ambidexterity that help a firm achieve environmentally sustainable outcomes. The complementarity view does not assume BA as a pre-condition for the development of organisational capabilities, instead, focusses on how BA can augment organisational existing capabilities for sustainable performance (Shi et al., 2022).

Second, prior research focusses on the operational and strategic implications of green IS (e.g., eco-efficiency; eco-effectiveness) and offers limited insights into the cultural aspect of sustainability. For example, research suggests that bottom-up green IS champions can drive business model and process transformation, resulting in eco-effectiveness at the strategic level (Hedman & Henningsson, 2016). IS complements sustainability innovations by replacing or reducing human labour and enabling new functionalities, leading to eco-effectiveness and eco-efficiency strategically and operationally (Hanelt et al., 2017). Although some studies suggest the importance of organisational value in shaping or transforming sustainability practices (Cooper & Molla, 2017; Hedman & Henningsson, 2016), very few of them have explicitly examined cultural factors for sustainability or explained the process for them to take place.

One study examines the cultural aspect of sustainability outcomes in top management's environmental orientation by using a variance approach to demonstrate that environmental orientation positively influences green IS actions (Loeser et al., 2017). Environmental orientation focusses on managers' commitment to sustainability practices. In addition to committing to sustainability, organisational members need to be aware of how they can

contribute to positive environmental impacts in accordance with business needs (Hu et al., 2016; Jenkin et al., 2011). Environmental awareness "was raised in the literature as an issue of concern but, to date, has received limited research attention" (Elliot, 2011, p. 221). To address this issue, we focus on how environmental awareness emerges from a firm's sustainability practices and helps the firm shape its environmental mindset over time.

Third, existing research offers little knowledge of how to use data to power sustainable practices. Environmental data are the foundation of analysing sustainability issues and have the transformative power to drive a firm's sustainability initiatives (Barnes et al., 2022; Gholami et al., 2016). BA, therefore, is becoming the catalyst for developing innovative sustainability solutions (Pappas et al., 2018). Contemporary organisations increasingly use sustainability analytics to understand their current performance, simulate possible scenarios to optimise processes and predict their impacts in the future (Balta et al., 2020). Research, however, has not sufficiently addressed how BA capabilities can be used to augment organisations' existing capabilities for environmental sustainability. As an example, of the empirical studies we reviewed, none of them has examined how BA interact with organisational existing capabilities to facilitate sustainability. In other words, research investigation has not reflected up-to-date business activities for data-driven sustainability.

2.2 | Ambidextrous capabilities

Ambidextrous capabilities refer to an organisation's ability to simultaneously conduct exploratory and exploitative activities, 'exploration–exploitation' suggests a both/and approach instead of making a choice between the two (Lavie et al., 2010; O'Reilly III & Tushman, 2013). In other words, a firm should engage in "sufficient exploitation to ensure its current viability and, at the same time, devote sufficient attention to exploration in order to ensure the organization's future viability" (Levinthal & March, 1993, p. 105). The notion of exploration–exploitation inherently resonates with sustainability because sustainable development requires meeting current needs without jeopardising the needs of future generations (World Commission on Environment and Development, 1987).

Exploration and exploitation have different foci: exploration develops new ways to prosper whereas exploitation uses existing resources to survive (Vessey & Ward, 2013). Driven by different objectives, they compete for the resources and time of a firm. To help firms achieve exploration–exploitation, researchers have suggested two ambidexterity approaches: structural ambidexterity and contextual ambidexterity (Gibson & Birkinshaw, 2004; O'Reilly III & Tushman, 2013). The structural approach suggests that organisations spread exploration and exploitation activities across functional units with complementary competencies (Birkinshaw et al., 2016). The contextual approach suggests that organisations create a context, featuring supportive processes and shared beliefs that facilitate organisational members to be ambidextrous (Birkinshaw & Gibson, 2004).

Despite its suitability, ambidexterity has not been well-examined in the area of sustainability (Maletič et al., 2014). Two studies investigate the role of ambidexterity in supporting sustainability. One study demonstrates that exploitation leads to incremental green innovation and exploration leads to radical green innovation (Chen et al., 2014). This study takes ambidexterity as a given and examines its environmental impacts using a variance approach. The other study investigates how an organisation develops ambidextrous capabilities to balance sustainability with profitability (Du et al., 2012). Our research focusses on the process of using ambidexterity to explore–exploit information to achieve environmentally sustainable outcomes and examine the role of BA in augmenting organisational ambidexterity.

2.3 | Business analytics capabilities

Recall that BA capabilities refer to the ability to use data to generate actionable insights for decision-making (Seddon et al., 2017). To realise the value of data-driven insights, organisations need to use their functional or dynamic

capabilities to implement these insights. In other words, BA capabilities need to interact with organisational capabilities to realise their value. For example, BA enables dynamic capabilities in sensing, seizing, and changing processes for firm performance (Torres et al., 2018), and BA complements customer involvement for digital innovation (Shi et al., 2022).

Extant literature, however, mainly focusses on the economic value of BA, with limited insights into how BA can lead to positive environmental impacts (Barnes et al., 2022). A few studies link BA to sustainability, but their discussion remains conceptual or focusses on BA capabilities themselves (Pappas et al., 2018; Zhang et al., 2022). We need empirical evidence to understand how BA can be used for sustainability, especially when interacting with an organisation's existing capabilities such as ambidexterity.

Prior research suggests that technologies enhance a firm's ambidexterity. For example, inter-organisational relationship systems enable contextual ambidexterity by improving operations and sensemaking (Im & Rai, 2014). IT training, spending, centralization, and usage intensity help structural ambidexterity at intra- and inter-organisational levels (Park et al., 2020). Using the insights from the IS ambidexterity research, we infer that BA facilitates firms' contextual and structural ambidexterity because it provides consistent, timely, and integrated information, and empowers front-line employees with the autonomy to make fact-based decisions.

3 | THEORETICAL FOUNDATION: DYNAMIC CAPABILITIES THEORY

Dynamic capabilities theory advances the resource-based view of an organisation, proposing that having valuable, rare, inimitable, and non-substitutable resources is insufficient to sustain competitive advantage and that developing and updating capabilities is essential to adapt to changes (Teece, 2007). The word 'dynamic' represents an organisation's capacity to renew its existing competencies in ever-changing environments, and 'capabilities' denotes sensing, seizing, and reconfiguring internal and external organisational resources and skills (Teece, 2010). Dynamic capabilities are critical for firms to adapt to changes in the sustainability area. Prior studies, based on a variance approach, demonstrate that sustainability-related dynamic capabilities result in high levels of environmental performance – see, for example, a literature review on dynamic capabilities for sustainability (Buzzao & Rizzi, 2021).

Our research takes a process approach to examine the interactions of different capabilities for environmental sustainability. It draws on two notions of dynamic capabilities: complementarity and evolutionary fitness. Complementarity occurs when the value of a capability is enhanced by the presence of another capability (Teece, 2007). Capability complementarity is difficult to be imitated because its development is path-dependent and causal ambiguous due to the non-linear effects, thereby offering the potential for competitive advantage (Lim et al., 2011). In this research, we argue that a firm's ambidexterity is enhanced when BA is present because it helps overcome resource and time constraints to explore–exploit environmental data. BA-ambidexterity complementarity offers a firm a competitive advantage in attaining sustainability, these capabilities are reflected in a firm's sustainability practices.

Evolutionary fitness refers to a strategic fit that involves a continuous process where internal capabilities adapt to an ever-changing environment (Teece, 2007, 2014). Drawing on evolutionary fitness, our research examines an adaptive process in which a firm continuously explores and exploits sustainability knowledge to align with and shape environmental changes. We also highlight the contextual conditions that impact a firm's environmental exploration–exploitation.

4 | RESEARCH DESIGN

In this section, we present the research design for the comparative case settings, followed by the background of the two case firms. We then present our data sources, followed by the data analysis approach.

4.1 | Comparative case study design

We chose the case study approach because there has been very little research examining BA-powered ambidexterity for sustainability, which requires an exploratory investigation of the phenomenon (Yin, 2014). Furthermore, the comparative case study approach allows us to develop an in-depth understanding of each case firm's sustainability practices, as well as to highlight the contextual factors that result in the differences in the practices between two case firms (Eisenhardt, 1989; Johns, 2006).

We started our case site selection using the convenience sampling strategy as Envizi was the first available and appropriate source that we could reach. Envizi develops the BA platform that measures and analyses organisations' environmental sustainability impacts. Based on Envizi, we selected two of its client firms (i.e., BankEx and GPT) as our case firms. To increase theoretical generalisability, we used the theoretical replication logic to choose a client firm from different industries (i.e., banking and real estate) that have different degrees of dynamism in sustainability requirements (Yin, 2014). Specifically, the banking industry has relatively stable environmental requirements with established methodologies for BankEx to comply with. On the other hand, the real-estate industry has more flexible and volatile environmental requirements because of the growth and development of properties and this presents GPT with high-level dynamism to strive for meeting environmental goals.

As our data collection proceeded, a consultancy firm Energetics emerged as an essential collaborator in helping BankEx and GPT with their environmental sustainability. To obtain a comprehensive understanding of the sustainability practices at BankEx and GPT, we collected data from four firms in a collaboration ecosystem. These firms are our focussed case sites including BankEx and GPT, the analytics software vendor firm Envizi, and the consultancy firm Energetics. Figure 2 presents the collaborative relationships in the ecosystem.

4.2 | Case background: BankEx and GPT

BankEx is a leading provider of financial services in Australia. The firm has been measuring and voluntarily disclosing energy use and greenhouse emissions since 2001, and adopted Envizi (the name of the BA software platform) in 2012. BankEx was the first Australian bank to roll out an onsite renewable energy programme for its retail branches

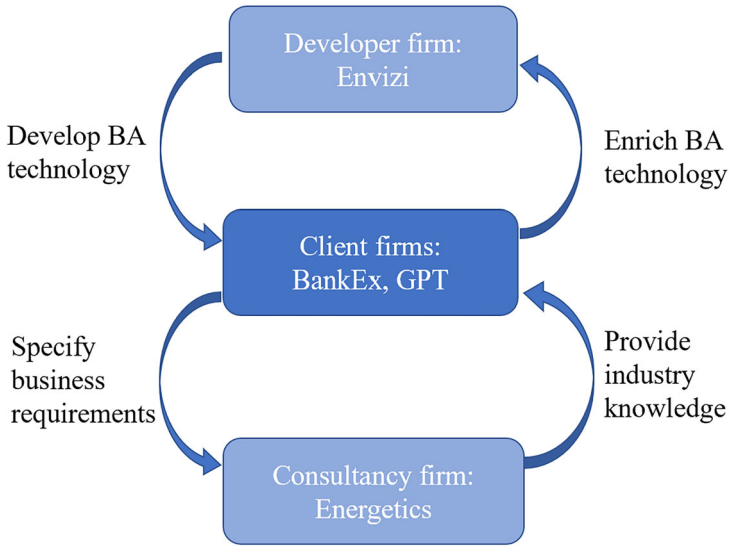

FIGURE 2 Ecosystem-wide collaboration between BankEx/GPT, Envizi, and Energetics.

and has continued to use BA to increase its sustainability performance. Major milestones of environmental sustainability at BankEx include reducing their domestic scope 1 and scope 2[1] carbon emissions by an amount equivalent to taking 1500 cars off the road for 1 year, and reaching a renewable energy lending exposure of A$2.2 billion, representing a year-on-year improvement of 63%. In collaboration with Energetics, BankEx released an Environmental and Social framework in 2021, outlining its key sustainability areas in climate change, human rights, biodiversity and agriculture, and fisheries and forestry.

GPT is a leading real-estate investment trust in Australia. It manages a portfolio of over A$16.2 billion of offices, logistics, and retail assets. GPT began using Envizi over a decade ago and has continued to collaborate with Envizi to develop analytics technology to support its sustainability objectives. For example, GPT co-developed the module previously known as the 'building energy performance analytics' in the Envizi platform to address the issue of declining efficiency in large energy-consuming assets. GPT has been a leader in the Dow Jones Sustainability Index for over a decade, ranking in the 99th percentile, and is among the top five most sustainable real-estate firms in the world.[2] Their corporate operations have been certified carbon-neutral for over 10 years. GPT collaborates with Energetics to streamline its business process of uploading and managing environmental data.

4.3 | Data sources

Our data sources consist of semi-structured, open-ended interviews and archival data (see interview protocol and archival data in Appendix 2, Tables A1–A4). For the two case firms, our interview questions started with the challenges and the key developmental areas of environmental sustainability. As data collection and data analysis progressed, the interview questions became more focussed on how the firms have explored and exploited resources to address specific sustainability issues to adapt to changes. For their collaborative organisations, we focus on how Envizi and Energetics help the case firms address their sustainability challenges and develop sustainability innovation. We conducted 18 online interviews using Zoom and Microsoft Teams from July to October 2021. Each interview lasted 45–60 minutes. Our interview participants are highly knowledgeable in sustainability and in the use of the BA software for sustainability (see participant information in Appendix 3).

Our archival data include sustainability reports, business reports, and media releases that amount to 502 pages of text. These data provide us with information on the background of each case firm, especially in its sustainability activities. We also use the archival data to contextualise the insights obtained from interview data analysis, strengthening the validity of our findings.

4.4 | Data analysis

We conducted a within-case analysis at BankEx and GPT to identify similarities in sustainability practices, followed by a cross-case analysis to compare the sustainability contexts that lead to differences in practices. To ensure the emergent process of building a theoretical model, we iteratively refined our interview questions as we analysed data (Corbin & Strauss, 2008a). We also constantly compared empirical evidence with the literature to sensitise theoretical concepts of sustainability practices (Gioia et al., 2013a). To increase the validity of our findings, we used data collected from multiple sources (e.g., different case sites, participants at different positions) and from different methods (e.g., interview and archival data) (Eisenhardt, 1989). To establish the research reliability, we used the coding scheme for sustainability practices developed in Table A5 in Appendix 4.

[1]Scope 1 refers to all direct emissions from the activities of an organisation or under their control; Scope 2 refers to indirect emissions from electricity purchased and used by the organisation. https://www.ghgprotocol.org/sites/default/files/ghgp/standards/Scope3_Calculation_Guidance_0.pdf

[2]Information retreived from GPT website https://www.gpt.com.au/news-insights/gpts-sustainability-leadership-recognised-inclusion-2020-gresb-real-estate-assessment

TABLE 1 Summary of existing theoretical concepts that informed coding.

Theoretical concepts	Definitions
IS-based environmental sustainability	The integration of people, technologies and processes to achieve environmental impacts that meet an organisation's current needs without compromising its abilities to prosper in the future (Elliot, 2011; Seidel et al., 2013)
BA capabilities	The abilities to transform data into actional insights (Seddon et al., 2017).
Ambidextrous capabilities	Organisations' abilities to simultaneously conduct exploratory and exploitative activities (Lavie et al., 2010; O'Reilly III & Tushman, 2013)
Contextual ambidexterity	Organisations' abilities to simultaneously pursue alignment and adaptability in a local context such as a business unit (Gibson & Birkinshaw, 2004; Im & Rai, 2014)
Structural ambidexterity	Organisations' abilities to conduct simultaneous exploration and exploitation by integrating internal and external resources at a global level i.e., across business units (O'Reilly III & Tushman, 2008; Park et al., 2020)

We used a three-level coding approach to conceptualise sustainability practices (Gioia et al., 2013a). Our coding involved the interplay of inductive and deductive reasoning (Corbin & Strauss, 2008b). Our first-order codes denote indicators of sustainability practices and are not ascribed to any theoretical meaning. In developing these indicators, we used inductive reasoning to stay close to participants' descriptions. We then combine first-order indicators into second-order concepts based on how a certain BA factor powers a type of ambidextrous practice by drawing on existing theoretical concepts using deductive reasoning. Table 1 summarises existing theoretical concepts that inform our coding.

5 | RESEARCH FINDINGS

In this section, we present the findings from within- and cross-case analysis. In the within-case analysis, we explain the theoretical concepts of BA-powered ambidextrous sustainability practices that are shared by BankEx and GPT. In the cross-case analysis, we compare the contextual conditions that highlight how the two case firms conduct sustainability activities differently.

Table 2 presents our three levels of codes. Based on contextual ambidexterity and structural ambidexterity (Gibson & Birkinshaw, 2004; O'Reilly III & Tushman, 2013), we combined the first-order codes when a certain BA factor (e.g., data availability, timeliness, analytics leadership) powers either contextual or structural ambidexterity. For example, because the availability of environmental data enhances contextual ambidexterity by improving employees' access and flexibility to explore–exploit, we combine first-order indicators that are associated with this into the second-order concept 'Data Availability-powered Contextual Ambidexterity'. We further combine second-order concepts into third-order dimensions i.e., 'BA-powered Contextual Ambidexterity' and 'BA-powered Structural Ambidexterity'.

We now introduce BA-powered contextual ambidexterity and BA-powered structural ambidexterity, in turn. We explain each concept using its first-order indicators (shown in italics), supported by empirical evidence from the interview or archival data and theoretical notions from the literature.

5.1 | BA-powered contextual ambidexterity

Contextual ambidexterity refers to an organisation's ability to pursue exploration–exploitation in a local context such as a business unit (Gibson & Birkinshaw, 2004). To achieve this, a firm uses performance management to stimulate employees to achieve high-quality outcomes, as well as provide employees with resources and trust to perform tasks ambidextrously (Birkinshaw & Gibson, 2004). In this section, we explain how BA factors (i.e., data availability; data timeliness; data-driven culture) power contextual ambidexterity from the aforementioned perspectives.

TABLE 2 Codes of BA-powered organisational ambidexterity.

First-order indicators	Second-order concepts	Third-order dimensions
Using BA to automate the process of uploading environmental data	Data availability-powered contextual ambidexterity	BA-powered contextual ambidexterity
Using BA to visualise data for reporting sustainability performance		
Using BA to improve data consistency		
Using real-time analytics to monitor sustainability performance	Data timeliness-powered contextual ambidexterity	
Generating alerts for environmental anomalies		
Making data-driven sustainability decisions	Data-driven culture-powered contextual ambidexterity	
Being flexible in using data to experiment with different sustainability approaches		
Data enable paradigm shifts in the sustainability mindset		
Integrating organisation-wide sustainability data for cross-function collaboration	Holistic insights-powered structural ambidexterity	BA-powered structural ambidexterity
Sharing sustainability data across organisations for collaboration		
Promoting inter- and intra-organisational analytics orientation	Analytics leadership-powered structural ambidexterity	
Championing analytics-driven sustainability initiatives		
Institutionalising business processes for analytics decision-making		

5.1.1 | Data availability-powered contextual ambidexterity

Data availability-powered contextual ambidexterity refers to the ability to foster organisational members' ambidextrous behaviours, augmented by the availability of consistent environmental data for sustainability decision-making (Gholami et al., 2016; Gibson & Birkinshaw, 2004). Recall that contextual ambidexterity can be achieved via performance management and organisational support (Birkinshaw & Gibson, 2004). From the performance management perspective, environmental data allow employees to effectively monitor and reflect on the performance of existing sustainability practices (Gibson & Birkinshaw, 2004). From the organisational support perspective, it offers information to support employees to proactively or reactively address the changes in sustainability requirements (Im & Rai, 2014; Sharma et al., 2014).

BankEx and GPT use BA software to *automate the uploading process of environmental data*[3] (e.g., energy consumption, carbon emissions and biodiversity), *improve the consistency of data*[4] from different sources and *visualise data for reporting environmental performance*. Specifically, the Envizi software consolidates environmental data for BankEx and GPT and visualises their sustainability performance for reviews, as commented by the CEO of Envizi:

[3]Text in italics represents a first-order indicator.

[4]Scope 3 refers to all other indirect emissions from activities of the organisation, occurring from sources that they do not own or control. https://www.ghgprotocol.org/sites/default/files/ghgp/standards/Scope3_Calculation_Guidance_0.pdf. We have excluded a few empirical studies that uses optimization or simulation methods to examine the enviornmetnal impacts of a particular system because these articles are not directly relevant to our phenomenon of interest.

> … we've got to bring all that data into the Envizi platform, … to store and categorize and normalize and clean up that data so that the customer has got a really clean data set… And so when you start to look at the amount of data that's required to come together to produce an environmental or carbon footprint, it's significant. And it's that complexity in and around all the siloed and distributed data.
>
> CEO and Co-founder, Envizi

Benefiting from BA, employees and managers are able to more efficiently identify environmental issues to improve sustainability performance (e.g., electricity and water usage). Furthermore, data visualisation increases the visibility of their sustainability outcomes. It, therefore, helps organisational members better reflect on current sustainability performance and broadens the scope of exploring opportunities for continuous innovation. For example, GPT has used analytical insights to assess their existing environmental performance and identify opportunities for innovation such as a new waste management approach.

5.1.2 | Data timeliness-powered contextual ambidexterity

Data timeliness-powered contextual ambidexterity refers to the ability to foster organisational members' ambidextrous behaviours, augmented by the timeliness of environmental data for sustainability decision-making (Gibson & Birkinshaw, 2004; Naseer et al., 2021). Timely data foster an organisational context where employees increase their responsiveness in tracking performance from a short-term perspective. Such a context also enables employees to be alert to unexpected issues and to proactively solve these issues, leading to long-term benefits (Im & Rai, 2014).

BankEx and GPT *use real-time analytics to monitor sustainability performance*. For example, BankEx uses IoT (Internet of Things) sensors to remotely monitor and adjust the energy consumption of their air conditioning units. Similarly, GPT uses IoT sensors to adjust its energy consumption based on changes in climate conditions. These IoT sensors provide real-time environmental data, enabling the timely and cost-efficient detection of environmental issues or anomalies (Naseer et al., 2021). Meanwhile, real-time analytics enable both firms to explore opportunities to initiate sustainability innovation. For example, GPT developed a 'real-time demand response' programme, allowing it to optimise a building's energy consumption to adapt to events that require different levels of electricity. Such initiatives improve sustainability performance in the long run, as illustrated by our archival data from GPT:

> BuildingEx [GPT's first office building] generates renewable electricity onsite and participates in a real-time demand response program that optimizes the building's energy consumption in response to peak demand events, reducing demand charges and the building's impact on the wider electricity network.
>
> Page 19, Archival Data No. AP5

BankEx and GPT *generate alerts for environmental anomalies*. The anomaly reports increase employees' alertness and speed in identifying environmental issues and fixing them in a timely and cost-effective manner (Naseer et al., 2021). These reports also enable them to prioritise important sustainability tasks and mobilise resources to realise sustainability value. The identification of anomalies allows employees to change business processes to solve issues, leading to sustainability innovation that generates long-term values. For example, a technical advisor from Envizi commented:

> So for a specific building, if the paper usage is much higher than usual, they [client company] can focus on the paper recycling or paper recycling processes in that building… if you put your data accurately into the platform, you can identify anomalies much faster and fix them before they become a problem. It's one of the biggest things with the building analytics system we have.
>
> Technical Advisor, Envizi

5.1.3 | Data-driven culture-powered contextual ambidexterity

Data-driven culture-powered contextual ambidexterity refers to the ability to shape organisational members' ambidextrous attitudes and behaviours, augmented by employees' shared beliefs in using data to change sustainability practices for both short- and long-term impacts (Gibson & Birkinshaw, 2004; Kiron et al., 2014). BankEx and GPT *empower employees to use data-driven insights for sustainability decision-making*. Data-driven insights equip frontline employees with the autonomy of changing their behaviours quickly and flexibly to adapt to emerging changes (Shi et al., 2022). When employees are given the freedom to make fact-based decisions, the interactions between organisational members tend to be driven by differences in skills and knowledge, instead of hierarchical rules (Kiron et al., 2014). Such interactions foster a trusting and reciprocal context where employees are willing to share ideas to explore or exploit sustainability knowledge (Birkinshaw & Gibson, 2004). For example, the sustainability lead at GPT commented that their employees make ground-breaking innovations empowered by data:

> Good and accessible data will lead to knowing where our end goal is, [and] will lead to good decisions to get there. My team gets up and has data for breakfast, our operations teams actually make the difference on the ground.
>
> Head of Sustainability and Energy, GPT

Data-driven culture also shapes an ambidextrous context by encouraging employees and managers to *experiment with different sustainability approaches or processes* based on analytical insights (Watson, 2016). The virtuous cycle between exploration and exploitation happens when using data-driven insights to discover opportunities for positive changes in sustainability. For example, based on the analysis of their non-utility data (e.g., transport fuels, accommodation), BankEx collaborated with Energetics to explore options for optimising their fleet to contribute to the reduction of carbon emissions, as noted by the executive director of Energetics:

> The bank [BankEx] has vehicles for regional banking services and/or executives in the city or mobile lenders … those vehicles create emissions… at some stage, they've got to make the decision to change the fleet … we're working with the bank, providing them with a range of analysis and options… for understanding and working out strategies.
>
> Executive Director, Energetics

In addition to strategic or operational implications on sustainability, analytics culture powers context-shaping capabilities by *promoting a paradigm shift in the sustainability mindset* of both firms (Krishnamoorthi & Mathew, 2018). Driven by the shared beliefs of using data-driven insights to understand and improve sustainability performance, BankEx and GPT shift their mindsets from focussing on internal operations to quantifying and improving external collaborators' business activities that influence their sustainability performance.

For example, benefiting from data-driven insights, employees at BankEx have shifted from short-term focus to long-term impacts. Specifically, BankEx not only aligns its activities to meet sustainability targets but also develops customers' resilience to environmental conditions. GPT advanced from reactively aligning its waste reduction in compliance with sustainability requirements to proactively preventing carbon emissions through tracking and quantifying tenant firms' sustainability-related activities. This practice is explained by its sustainability lead as follows:

> Shifting… we are custodians, not actually the generators of this material. So getting the buy-in from our tenants and looking at what we buy, not just what is wasted… the real trick is going to be, how do we get that measurement of the materials in the first place?… we need to look at the other side of the equation, what we buy, not just what we manage through a waste contract.
>
> Head of Sustainability and Energy, GPT

5.2 | BA-powered structural ambidexterity

Structural ambidexterity refers to an organisation's ability to explore–exploit by integrating internal and external resources at a global level i.e., across business units (O'Reilly III & Tushman, 2008; Park et al., 2020). The integration relies on effective linking mechanisms that ensure alignment and consistency (Jansen et al., 2009). At BankEx and GPT, structural ambidexterity happens internally via the collaboration across different departments and externally through the collaboration with Envizi and Energetics. In this section, we explain how holistic insights and analytics leadership power structural ambidexterity at intra- and inter-organisation levels.

5.2.1 | Holistic insights-powered structural ambidexterity

Holistic insights-powered structural ambidexterity refers to the ability to conduct simultaneous sustainability exploration and exploitation augmented by analytical insights that provide a holistic view for collaboration (Božič & Dimovski, 2019). BankEx and GPT *integrate organisation-wide environmental data to develop holistic insights* into their sustainability performance. These insights provide a high-level, shared understanding across departments about a firm's sustainability activities. The shared understanding is important for different teams to align their business activities with a firm's sustainability goals to exploit existing sustainability knowledge, as well as to explore new opportunities (Grover et al., 2018). For example, BankEx used to mainly focus on their scope 1 and 2 emissions. Informed by the BA analysis results, the sustainability team identifies the opportunities to reduce their scope 3 emissions by reducing paper consumption. Therefore, the sustainability team started collaborating with the procurement team to optimise its procurement portfolio to improve sustainability performance, as commented by its sustainability analyst:

> We need to source more carbon-neutral paper to reduce our emissions related to office paper consumption. So, we can give that insight to our procurement team to reach out to the vendors to update some of their new tenders and contracts… we do give those insights to other departments, but we don't necessarily directly make the decisions.
>
> Energy & Sustainability Analyst, BankEx

At GPT, the BA dashboard helps the firm integrate data to visualise its sustainability performance on water and energy consumption. The visualisation provides a single source of truth for different operational teams to collectively identify issues and adapt to changes when needed, as noted by the product manager from Envizi:

> …we have BEPA, building energy performance analytics. That was the module that we actually developed in partnership with GPT several years back…which is basically a certain way to manage energy consumption… sort of religiously reviewing my energy consumption on a daily and weekly basis. And when there is a problem, I'm going to act and resolve those just quickly as I can. So that's the BEPA module.
>
> Product Manager 3, Envizi

BankEx and GPT use the BA platform to *share sustainability data for inter-organisational collaboration*. Information sharing is crucial for both firms to leverage collaborators' expertise to exploit and explore sustainability knowledge (Park et al., 2020). BankEx and GPT are knowledgeable in their sustainability activities whereas Energetics is specialised in market knowledge such as emerging sustainability areas and new clean technologies. Facilitated by the data sharing over the Envizi platform, Energetics helps both firms better attain their sustainability goals and develop some initiatives. For example, using the BA platform, Energetics thoroughly understands the key factors that drive GPT's sustainability performance. Complemented by their extensive knowledge in the sustainability area, Energetics helps GPT set sustainability targets in the short term and formulate sustainability strategies for long-term development.

Energetics also helps BankEx to summarise sustainability performance and predict the trend of energy usage at its banking sites. The information sharing between Energetics and BankEx enables the bank to flexibly adjust its solar power usage to adapt to the sustainability requirements in the market. The energy accounting manager from Energetics commented:

> I guess our value-adding is that we consolidate those data into more user-friendly reports. We consolidate it into the site, summing it up to like site usage and then presenting it to them [BankEx], sort of like charts so that they can easily see the trends… for us, it's the day-to-day managing of their data … they can also monitor like how much usage they have and [understand] how much they need to offset with that power usage agreement.
>
> Energy Accounting Manager, Energetics

5.2.2 | Analytics leadership-powered structural ambidexterity

Analytics leadership-powered structural ambidexterity refers to the ability to explore–exploit sustainability knowledge, augmented by leaders' initiatives and commitment to drive the use of BA at organisational and ecosystem levels (Krishnamoorthi & Mathew, 2018; Seddon et al., 2017). Leaders at BankEx and GPT *promote analytics activities at both intra- and inter-organisation levels*. Both firms organise regular meetings to review data-driven sustainability performance. Based on the performance review, they develop a shared view of how to fix the issues identified and seize the opportunities to introduce new sustainability initiatives. For example, the sustainability team at GPT meets with the firm's leadership team to discuss asset performance using the Envizi platform. The regular meetings reinforce the firm's orientation of using analytics to drive sustainability performance.

Furthermore, because Envizi and Energetics have distinct and complementary sustainability knowledge, the sustainability lead at BankEx organises meetings with both collaborating firms on how to better use the BA platform to streamline their reporting processes or optimise their sustainability processes. As an example, the sustainability manager at BankEx commented on the leadership-powered inter-firm collaboration:

> So we meet, you know, at least quarterly. Last week, we had a discussion with the three parties [BankEx, Energetics, and Envizi]…So we're saying, look, we do our annual report, we do DJSI (Dow Jones Sustainability Indices), CDP (Carbon Disclosure Project)…, etc. And they all need slightly different reports. How can we possibly use Envizi's PowerBI function? So we have been meeting to see how we can optimize some of the reporting, or streamline it.
>
> Energy & Sustainability Manager, BankEx

BA provides BankEx and GPT with thorough, in-depth insights into how they can change processes and/or strategies to better use sustainability to reduce cost and drive innovation. To promote the positive effects of data-driven sustainability, leaders at both firms *champion analytics-driven sustainability initiatives* by exploring and exploiting knowledge from different stakeholders. BankEx explores investment opportunities by exploiting the market knowledge from Energetics. For example, leaders at BankEx use Energetics's expertise and experience to forecast their client firm's sustainability performance, such as how climate change would affect a client firm in the agriculture industry. Using these insights, BankEx formulates its investment strategy. Furthermore, to facilitate a successful implementation of new clean energy technologies, leaders at GPT commit to these sustainability initiatives by structuring expertise from different collaborators, as noted by its building performance manager:

> I think that for us, more so when we're doing like risk assessments into novel technologies… it's actually getting as much involvement with so many other people… So, hearing the insights from these

> guys, we had our suppliers, a range of consultants, electrical contractors to help … paint a bigger picture because I might have a certain viewpoint or certain knowledge base on that, but for something as critical as that, it's as much to get that input from as many different people.
>
> National Manager, Building Performance, GPT

Leaders at BankEx and GPT *institutionalise business processes for analytics decision-making*. Establishing relevant business processes helps both firms inject the legitimacy of using data-driven insights to guide or improve sustainability-related activities (Krishnamoorthi & Mathew, 2018). Furthermore, business processes ensure the efficiency of sustainable business decision-making. For example, BankEx establishes the processes that require facility managers at a branch to adjust their energy usage based on analytics reports, which summarise the usage across different branch sites and define a recommended threshold for a branch based on its size and historical usage. The sustainability analyst at BankEx commented on establishing this standard report practice:

> The more frequently you give them [facility managers] this data, the more aware that they become of this problem … So, it has a benefit from a cost perspective, but also [from] an emissions perspective. It's sort of easy to sell a problem to upper-level management, to make that part of standard practice for a lot of the facility managers to incorporate within their standard operations.
>
> Energy & Sustainability Analyst, BankEx

At GPT, the leadership team took the initiative to establish a unique waste management process that categorises wastes into grades (A, B and C) based on the rating of the value retention of materials. Such a waste management process enables GPT to be more aware of exploring the opportunities to purchase A-grade materials, which not only improves the short-term efficiency of reporting but also has long-term impacts on waste management.

5.3 | Comparative analysis between BankEx and GPT

BankEx and GPT engage in different degrees of exploration–exploitation. Specifically, BankEx conducts more exploitation, whereas GPT conducts more exploration. To explain the differences, we focus on the contextual factors in the cross-case analysis (Hong et al., 2014). By contextual factors, we mean the situational factors that offer opportunities or constraints for the occurrence of sustainability practices (Johns, 2006).

Our analysis suggests three factors i.e., organisational identity, sustainability dynamism, and ecosystem-wide collaboration explain why GPT is more explorative and BankEx is more exploitative in their sustainability practices. Note that both firms engage in exploration–exploitation, as presented in the within-case analysis, but we focus on explaining why they conduct one more than the other in this section.

5.3.1 | Organisational identity

Organisational identity refers to the core and enduring characteristics that distinguish a firm from its peers (Whetten, 2006). These distinctive characteristics are manifest in organisational vision, members' shared beliefs, competencies, etc (Gioia et al., 2013b). At GPT, organisational members commit to providing high-quality real-estate spaces that enable their customers and communities to excel and prosper sustainably. The resilience of environmental resources is fundamental to supporting business activities and delivering financial returns as GPT progresses to a low-carbon future.

The proactive stance enables GPT to view sustainability as an opportunity more than a risk. For example, the firm focusses more on exploring new approaches to attain its sustainability goals than on aligning with existing regulations. Furthermore, the firm defines itself as the lead to drive the industry to transition to a low-carbon economy. This industry-leading identity motivates the firm to use its experience and knowledge to constantly question the status quo and to seek out new ways to conduct sustainability activities, as commented by its sustainability head:

> In the past three years, [we] have shifted the focus to more resilience, which is looking much longer term in terms of the impacts on climate change, [which is] probably the biggest area of investment… And being in a space where you are leading a transition to a low-carbon economy, we're finding it's less about risk and more about opportunities.
>
> Head of Sustainability and Energy, GPT

BankEx's identity is characterised by improving the financial well-being of customers and communities. Compared with GPT treating sustainability as an opportunity to drive growth, BankEx operates in a highly regulated industry and focusses on mitigating environmental risks by complying with sustainability metrics defined in the industry. Although BankEx uses BA insights to explore sustainability-related opportunities such as client investment and sustainability-related loans, the firm takes an alignment approach to address the sustainability risks or requirements most of the time. For example, the corporate sustainability manager of BankEx commented:

> BankEx isn't a leader in this space, in the sustainability space amongst peers or amongst other corporates… So more and more now it's being driven by investors… It's being driven by clients and customers to a degree… I guess we're probably originally more risk-driven, like these are risks that we need to be considering.
>
> Manager, Corporate Responsibility, BankEx

Compared with GPT committing to a strong sustainability identity, BankEx is at its early stage of promoting sustainability across organisational levels. The implementation of sustainability may be pushed back by middle-level managers due to the lack of information on how sustainability impacts customer experience or profitability. To address these issues, executive-level leaders and the sustainability team are driving sustainability initiatives using data-driven evidence to highlight the financial impacts of sustainability investment, as noted by its corporate responsibility manager:

> When you come into that middle level of management… there's pushback for whatever reason… So [we] come up with a better number and justify it … If we expand it to not just low carbon and sustainability and if we do this and all that sort of thing, and instead of $15 billion [investment] by whenever, we can actually achieve like $50 billion or $70 billion.
>
> Manager, Corporate Responsibility, BankEx

5.3.2 | Sustainability dynamism

Sustainability dynamism refers to the degree of uncertainty and the speed of change in environmental sustainability requirements and peer firms' sustainability practices that a firm is confronted with (Strauss et al., 2017). GPT faces high-level dynamism because the firm is continuously expanding its building portfolio, leading to frequent changes in sustainability requirements. To adapt to changes, the firm initiates sustainability targets for its buildings to meet and explores new approaches for peer firms to follow, as noted by its sustainability lead:

> We are now working through the retail portfolio, there isn't a strong validation pathway for retail. We're piloting assets next year and we've been working with Climate Active, and GBCA (Green Building Council of Australia) to get a sensible validation approach. So, we are very big on trying to help create channels that are relevant for an entire industry…And we're finding many of our counterparts have jumped on board and are following the same protocols that we established a couple of years ago.
>
> Head of Sustainability and Energy, GPT

BankEx, on the other hand, has a relatively stable building portfolio, thereby facing low-level changes in sustainability requirements. The operations of these buildings follow the sustainability metrics defined in the industry. Compared with initiating new approaches, BankEx more focusses on optimising its operational efficiencies and aligning its sustainability practices with existing sustainability metrics. For example, Energetics helps BankEx benchmark its sustainability practices against industry standards, as explained in the quote below:

> Benchmarking their [BankEx] commercial sites against the average commercial site, how they are performing and then bringing that insight to them [BankEx] potentially. They are reporting under Climate Active and we do know those [emission] boundaries at the moment.
>
> Principal Consultant in Energy and Carbon Markets, Energetics

5.3.3 | Ecosystem-wide collaboration

Ecosystem-wide collaboration refers to the extent to which a firm collaborates with business partners in the data-driven sustainability ecosystem (Corbett & Mellouli, 2017). In our research, we focus on the ecosystem consisting of a focal firm, its BA software vendor (Envizi), and its consultancy collaborator (Energetics). Both BankEx and GPT actively collaborate with their ecosystem partners, but the ways in which they collaborate differ.

GPT exploits sustainability information through its ecosystem collaboration for sustainability innovation. Because the firm has the experience and expertise to develop its own approaches and targets to address sustainability issues, it uses external collaboration to access and integrate environmental data. For example, the firm outsources data uploading and consolidation tasks to Envizi and Energetics. From a structural ambidexterity point of view, GPT achieves exploration–exploitation by separating these two types of activities across business units (O'Reilly III & Tushman, 2008). For example, its sustainability lead commented:

> We developed something that responded to the commitments and then Envizi responded to our requirements as a customer. So I guess you could call it collaboration. We told them what we wanted and they delivered it … It's just a monthly snapshot summary, but for us, it's still handy to bring it together as part of our overall dashboarding.
>
> Head of Sustainability & Energy, GPT

The ecosystem-wide collaboration at BankEx is driven by its needs in sustainability reporting and compliance. Because the sustainability team at BankEx has not established sophisticated data analytics functions, the firm uses Energetics's expertise to generate sustainability insights for strategic and operational decision-making. Ecosystem collaboration at BankEx is more exploration oriented. For example, using the Envizi platform, Energetics helped BankEx to attain sustainability goals ranging from emission scope 1 to scope 3, as explained in the quote below:

> We are already doing some scoping exercises [and] some evaluation exercises for them [BankEx] to see the different scenarios that they have to expand that boundary to improve other emissions sources… We are obviously coming in with a view that we will be able to partner with [BankEx] in a broader space. I think that definitely plays a very big role in their decisions because of the breadth of services that we can offer.
>
> Principal Consultant in Energy and Carbon Markets, Energetics

6 | THEORETICAL MODEL OF BA-POWERED AMBIDEXTERITY FOR ENVIRONMENTAL SUSTAINABILITY

Based on our analysis, we developed a theoretical model of BA-powered ambidexterity for environmental sustainability in Figure 3. Our model draws on the dynamic capabilities theory, especially on its notion of complementarity and evolutionary fitness (Teece, 2007, 2014). We use complementarity to explain how ambidextrous sustainability practices are augmented when BA is present. We use evolutionary fitness to explain how contextual factors condition BA-powered ambidextrous practices to achieve sustainability outcomes in continuously adapting to ever-changing environments.

The model posits three types of relationships: (1) BA augments ambidextrous sustainability practices; (2) contextual factors condition BA-powered ambidextrous practices; and (3) BA-powered ambidextrous practices lead to sustainability outcomes. We discuss these relationships, in turn.

6.1 | BA augments ambidextrous sustainability practices

Environmental exploration–exploitation is exemplified in reciprocal relationships where organisational members use existing knowledge to develop new sustainability processes and deploy the newly developed knowledge for incremental improvement (Lavie et al., 2010). Environmental exploration–exploitation is powered by the use of BA via two mechanisms.

A mechanism refers to the process that underlies the occurrence of empirical events to achieve certain outcomes (Henfridsson & Bygstad, 2013; Wynn Jr & Williams, 2012). Because a mechanism cannot be observed directly, researchers suggest 'analytical validation' to establish the validity of developing a mechanism (Wynn Jr & Williams, 2012, p. 796). We, therefore, infer the underlying logic for certain sustainability practices to occur based on common patterns of how BA powers ambidexterity that emerge from data, as well as on insights from the literature on BA and ambidexterity. Table A6 in Appendix 4 presents the coding examples for the mechanisms identified: BA-powered context shaping and BA-powered resource linking.

6.1.1 | BA-powered context shaping mechanism

BA-powered context-shaping mechanism refers to the process through which data availability, timeliness, and data-driven culture foster an organisational context that allows employees to flexibly engage in sustainable exploration–exploitation activities (Gholami et al., 2016; Gibson & Birkinshaw, 2004; Kiron et al., 2014; Naseer et al., 2021). This mechanism explains sustainability practices at the local level. Specifically, BA shapes the ambidextrous context that allows employees to track sustainability performance and obtain support technically and socio-organisationally.

From a technical perspective, rich and timely sustainability information fosters an organisational context that enhances employees' agility and effectiveness to address current issues and to develop sustainability strategies for long-term impacts (Im & Rai, 2014). BA increases organisational accessibility to information and enables employees to sense and seize opportunities for incremental and radical innovation (Gupta et al., 2006). Compared with the

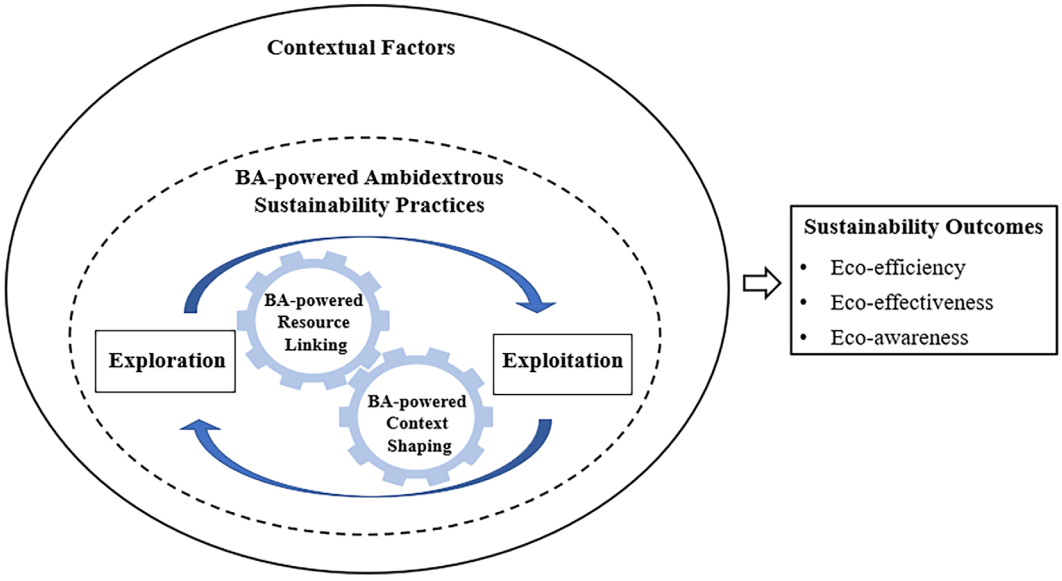

FIGURE 3 Theoretical model of BA-powered ambidexterity for environmental sustainability.

traditional model of people physically investigating energy consumption, our case firms use BA to gain insights from data captured by smart metres, which generates real-time information on sustainability performance. This provides an unprecedented advantage for employees to quickly respond to anomalies and adapt to external sustainability changes. For example, using alerts to real-time environmental anomalies, employees at GPT are able to respond quickly to environmental issues and also leverage analytics insights to develop a real-time demand response programme.

From a socio-organisational perspective, BA strengthens organisational members' beliefs in evidence-based sustainability decision-making (Krishnamoorthi & Mathew, 2018). This helps to shape an organisational context that promotes and values data-driven insights, and empowers front-line employees with the autonomy to adjust their behaviours to explore–exploit. Furthermore, data-driven decision-making encourages knowledge exchange via experimentation and trial-and-error learning, which nurtures trusting relationships among organisational members who are beneficial for the emergence of sustainability innovation (Gibson & Birkinshaw, 2004). For example, a data-driven culture promotes collaboration across different operational teams and the sustainability team in our case firms. This led to an energy consumption demand response programme at BankEx and a new waste management approach at GPT.

6.1.2 | BA-powered resource linking mechanism

BA-powered resource linking mechanism refers to the process through which analytics insights and leadership facilitate the integration of resources across internal and external business units for sustainable exploration–exploitation (Božič & Dimovski, 2019; O'Reilly III & Tushman, 2008; Seddon et al., 2017). This mechanism explains sustainability practices at the intra- and inter-organisational levels from both technical and socio-organisational perspectives.

Structural ambidexterity relies on the integration of knowledge across business units (Birkinshaw et al., 2016). Technically, analytical insights provide a single source of truth that integrates fragmented data about sustainability performance (Božič & Dimovski, 2019). At the intra-organisational level, synthesised insights enable the sustainability team and other teams (e.g., procurement and customer management) to develop a shared understanding of their sustainability performance. Shared understanding helps specify responsibilities in delivering sustainability outcomes,

and facilitating exploration–exploitation across teams. At the inter-organisational level, effective collaboration relies on a shared vision of integrating complementary knowledge possessed by ecosystem partners. Effective integration creates synergistic effects, facilitating the initiation of new sustainability targets or the attainment of sustainability goals established by the industry (Corbett & Mellouli, 2017).

From a socio-organisational perspective, leadership promotes analytical activities across sustainability-related units internally and externally (Seddon et al., 2017). The top-down initiatives increase the commitment of internal departments to use data-driven insights to explore–exploit sustainability knowledge. For example, driven by the initiatives from the sustainability leadership, functional teams at GPT collaborated to develop a new waste reporting tool. Furthermore, leaders of our case firms actively reached out to Envizi and Energetics to promote ecosystem-wide collaboration.

6.2 | Contextual factors condition BA-powered ambidextrous practices

As demonstrated in our comparative analysis, BankEx and GPT engage in different degrees of exploration–exploitation, depending on three contextual factors, i.e., organisational identity, sustainability dynamism, and ecosystem-wide collaboration. Table 3 summarises how these three contextual factors condition the two case companies' sustainability practices.

With regard to *organisational identity*, when sustainability lies at the core of an organisation's identity, the firm tends to proactively explore opportunities for sustainability innovation using data-driven sustainability insights (Gioia, Patvardhan, et al., 2013). Driven by its sustainability identity, GPT more actively seeks new ways to enhance its environmental performance compared with incremental improvement. When sustainability is not the central element in an organisation's identity, the firm is likely to take a compliance approach to address environmental issues by following established metrics. For BankEx, environmental sustainability is a key area for business reporting and although it is an important element, it is not core to its business objective. As a result, BankEx takes a more exploitative approach to meet environmental requirements compared with taking initiatives to drive sustainability innovation in the industry.

With regard to *sustainability dynamism*, when uncertainty and changes in environmental requirements are high, a firm tends to develop new practices to cope (Strauss et al., 2017). The industry in which GPT operates lacks established guidelines on how to become carbon neutral in retail properties, presenting a high level of uncertainty fT to achieve sustainability targets. In turn, this triggers GPT to continuously explore new ways of developing its sustainability approaches. When the requirements for sustainability are established in an industry, a firm is likely to use existing methodologies and guidelines to meet sustainability goals. Compared with GPT, BankEx faces a lower level of dynamism because its stock of branches and commercial buildings remains relatively stable. As a result, BankEx conducts more exploitation activities to comply with industry requirements on environmental issues.

With regard to *ecosystem-wide collaboration*, when the degree of collaboration with ecosystem partners is high, a firm tends to use the collaborator's expertise and knowledge to conduct more exploitative activities (Corbett & Mellouli, 2017). For example, Energetics plays a major role in helping BankEx assess its emission sources, define sustainability targets and devise strategies to minimise negative environmental impacts. When the degree of collaboration with ecosystem partners is low, a firm tends to explore opportunities and approaches to attain sustainability goals using internal expertise. For example, GPT develops its sustainability processes and strategies by using external collaboration to conduct exploitative tasks such as data uploading and data consolidation.

6.3 | BA-powered ambidextrous practices Lead to sustainability outcomes

We identify three sustainability outcomes: eco-efficiency, eco-effectiveness and eco-awareness. Table A6 in Appendix 4 presents our coding examples for these outcomes. *Eco-efficiency* refers to the operational efficiencies of

TABLE 3 A comparison of contextual factors that condition sustainability practices.

Contextual factors	GPT	BankEx
Organisational identity	Sustainability is the core element of organisational identity Exploration-oriented practices to proactively seek new ways to enhance environmental performance	Sustainability is the supporting element of organisational identity Exploitation-oriented practices to address sustainability risks and ensure compliance
Sustainability dynamism	High level Exploration-oriented practices to develop new approaches to adapt to changes	Low level Exploitation-oriented practices to align its sustainability practices with existing sustainability metrics
Ecosystem-wide collaboration	Low level Exploit sustainability information through ecosystem collaboration	High level Explore new sustainability approaches through ecosystem collaboration

business processes that reduce the impacts of ecological degradation (Chen et al., 2008; Hanelt et al., 2017). BA-powered exploration–exploitation achieves eco-efficiencies by identifying and solving environmental issues in a timely and cost-efficient manner. For example, IoT sensors help BankEx and GPT monitor and adjust their energy consumption in real-time and help reduce the cost of dispatching technicians to investigate certain issues.

Eco-effectiveness refers to the development of new processes and approaches to increase the effectiveness of ending environmental degradation (Chen et al., 2008; Hanelt et al., 2017). Compared with eco-efficiency, which focusses on the cost of addressing environmental issues, eco-effectiveness focusses on the utility of reducing negative environmental impacts. This is achieved by exploring opportunities to develop ecologically effective business approaches via exploiting analytical insights. For example, using the insights derived from waste management data, GPT developed a new waste reporting tool that significantly contributes to the reduction of lower-grade materials ending up in a landfill. Furthermore, BankEx collaborates with Energetics to explore scenarios for optimising their financial emissions.

Eco-awareness refers to organisational members' alertness to environmental issues and shared understanding of how they can change their behaviours for positive environmental impacts (Elliot, 2011; Jenkin et al., 2011). BA-powered ambidextrous practices lead to eco-awareness because they strengthen organisational members' beliefs in both the necessity and usefulness of data in powering sustainability performance. Such beliefs encourage organisational members to stay alert to environmental risks and opportunities and adapt business activities to address them.

Furthermore, exploration–exploitation leads to eco-awareness that brings a paradigm shift in environmental thinking (Elliot, 2011). Both firms have shifted from an internal focus to an external orientation to produce larger environmental benefits. For example, environmental data inform GPT about the tenants that are largely responsible for consuming electricity, water, and gas, and for generating waste. Therefore, moving beyond training their employees, GPT started to develop a strategy to educate their customers on how to improve sustainability performance. Using BA-driven insights, BankEx also shifted focus from its financial emissions to scope 3 emissions, leading them to reconsider how they could encourage their customers to develop sustainable activities within a broader community.

7 | IMPLICATIONS AND FUTURE RESEARCH

In this section, we present the implications of our research for theory and for practice, followed by its opportunities for future research.

7.1 | Implications for research

This research advances existing literature in three aspects. First, how IS interact with organisational capabilities to achieve environmental sustainability is critical but receives insufficient understanding from the IS sustainability literature (Elliot & Webster, 2017). Among the technologies that have been used for sustainability, BA is increasingly gaining traction in the industry but is far less understood in scholarly discourse (Barnes et al., 2022; Pappas et al., 2018). Furthermore, ambidexterity offers promising effects on sustainability (Du et al., 2012; Lavie et al., 2010), but researchers have not addressed how a firm should explore–exploit, especially when it is constrained by limited resources and time.

Our model addresses these issues by positing a dynamic process of how firms can use BA to augment organisational ambidexterity to achieve environmental sustainability in operational, strategic, and cultural dimensions. We uncover two mechanisms to explain how BA power exploration–exploitation practices from both technical and socio-organisational perspectives. Our model also suggests a firm engages in different degrees of exploration–exploitation, depending on specific contextual factors.

Second, our research contributes to the BA literature by explaining how BA can realise its environmental value (Barnes et al., 2022; Gholami et al., 2016). Prior literature largely focusses on the business value of BA including financial performance and market growth (Božič & Dimovski, 2019; Shi et al., 2022). IS researchers have started to study BA-driven environmental sustainability. Existing research, however, remains largely conceptual or focusses on designing a data analytics system (Barnes et al., 2022; Pappas et al., 2018). We need empirical evidence to provide more contextualised and actionable knowledge to understand how BA powers organisational existing capabilities to develop competitive advantages through environmental practices.

Our research addresses this need by explaining the process of using different BA factors to enhance exploration–exploitation. Specifically, data availability, timeliness, and data-driven culture shape an organisational context that has rich, timely information and empowers autonomy for employees to swiftly react to sustainability issues and proactively sense innovation opportunities. Holistic insights and analytics leadership integrate resources across business units at organisation and ecosystem levels, developing a shared vision and complementary skills for a firm to explore–exploit sustainability knowledge.

Third, our research contributes to the literature on environmental sustainability outcomes from two perspectives. We identify a cultural dimension of sustainability outcomes, i.e., eco-awareness. Prior research has not paid sufficient attention to the organisational culture of sustainability. Researchers have suggested leaders' commitment to environmental sustainability by focussing on environmental orientation (Loeser et al., 2017). Eco-awareness suggests that organisational members develop shared beliefs that they need to stay alert to environmental issues and be reflective on their assumptions of how to conduct activities to be ecologically responsible.

Our research also enriches the understanding of eco-efficiency and eco-effectiveness (Elliot & Webster, 2017). We suggest that firms move along the exploration–exploitation continuum in achieving these sustainability outcomes. Specifically, exploitation-oriented activities are more associated with eco-efficiency because they focus on fixing current environmental issues. Exploration-oriented activities are more associated with eco-effectiveness because they help develop new approaches that reduce negative environmental impacts in the long term.

7.2 | Implications for practice

For organisations wishing to become more environmentally sustainable, our research offers three implications. First, organisations should simultaneously pursue BA-powered exploratory and exploitative sustainability to balance both current and future needs. Leaders shall recognise that overly exploiting existing knowledge and competencies does not guarantee effective adaptation to changes in sustainability requirements, nor does it guarantee sustainable competitive advantage. Meanwhile, firms also need to be cautious of overly committing to explorative activities that may

increase the risk of losing stability and efficiencies in addressing the environmental problems that it is facing at present.

Second, organisations should use both the technical and socio-organisational factors of BA to power their sustainability practices. From a technical perspective, organisations ensure that environmental data are accessible, consistent, and timely for decision-making. Also, firms use BA to provide a single source of truth to guide collaboration internally and externally. From a socio-organisational perspective, organisations develop a data-driven culture to strengthen employees' beliefs in using data to explore-exploit sustainability knowledge. Furthermore, leaders need to commit to and promote analytics-informed sustainability improvement and innovation.

Third, organisations should participate in ecosystem collaboration to attain sustainability outcomes. Ecosystem collaborators have complementary knowledge and skills, so effective collaboration can create synergistic effects on explorative and exploitative sustainability activities. To develop effective collaboration, leaders must establish business processes to facilitate ecosystem-wide collaboration, promote data-driven communications with collaborating organisations, and articulate a shared vision of how to attain sustainability targets in the short term and to develop sustainability innovation in the long term.

7.3 | Opportunities for future research

We have identified three opportunities for future research to investigate. First, although we examine firms from two industries, we expect our model to be generalisable beyond these two. Future research could validate the model in firms from other industries. Through the validation, researchers may modify or enrich the model by incorporating industry-specific factors that influence sustainability activities. Furthermore, our research examines sustainability practices in established firms. We encourage future studies to investigate sustainability practices in startup firms. Using our research findings, researchers may compare similarities and differences in sustainability practices between startup and established firms.

Second, our research focusses on how BA-powered ambidextrous practices lead to sustainability outcomes. Future research could investigate a cyclical process between sustainability practices and outcomes. Our data analysis has demonstrated preliminary insights into the reciprocal relationship. For example, the sustainability outcome eco-awareness enables employees to better make sense of environmental opportunities and exploit resources to seize these opportunities, which further results in improved eco-efficiencies or eco-effectiveness. We encourage researchers to examine how sustainability practices and outcomes shape and are shaped by each other over time.

Third, this research examines environmental sustainability only. Via data analysis, we find that environmental sustainability outcomes are associated with financial outcomes. For example, BA-powered eco-efficiency reduces the costs of resolving environmental issues, this positively contributes to a firm's financial performance. We encourage researchers to examine sustainability issues by advancing from a single dimension to multiple areas. Future research may address issues such as how technology-powered environmental sustainability influences economic sustainability, this will lead to a better understanding of environmental sustainability as a source of competitive advantage.

8 | CONCLUSION

Despite the extensive application of BA technologies in the sustainability industry and the inherent resonance of ambidexterity with sustainability, research to date has not developed a sufficient understanding of how BA work with ambidextrous capabilities to achieve environmentally sustainable outcomes at an organisation. Our research addresses this relevant, important problem by developing a model of BA-powered exploration–exploitation for environmental sustainability based on a comparative case study at a bank and a real-estate trust.

The model suggests that a firm should engage in a continuously adaptive process to explore–exploit environmental knowledge to ensure short-term efficiencies and long-term viability. Two mechanisms underlie the adaptive process. The BA-powered context shaping mechanism takes effect at a local level (e.g., a business unit) powered by data availability, timeliness, and data-driven culture. The BA-powered resource linking mechanism takes effect at a global level (e.g., a business ecosystem) powered by holistic analytics insights and analytics leadership. These mechanisms also explain the environmental value of BA, complementing prior research that mainly focusses on BA economic value. A BA-powered environmental outcome, i.e., eco-awareness, receiving far less attention compared with eco-efficiency and eco-effectiveness, has demonstrated its role in shaping employees' environmental beliefs and catalysing a paradigm shift in an organisation's sustainability mindset.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

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APPENDIX 1: EMPIRICAL STUDIES ON IS ENVIRONMENTAL SUSTAINABILITY

Paper	Theoretical foundation	Research focus	Key findings	Research method	Journal
Benitez-Amado and Walczuch (2012)	Resource-based theory	IT-enabled environmental strategy capabilities	IT enables proactive environmental strategy; and environmental strategy mediates the relationship between IT capabilities and firm performance.	Survey	EJIS
Butler (2011)	Institutional theory	IS-enabled sense-making, decision-making, and knowledge creation capabilities	Three aspects (i.e., regulative; normative; cultural-cognitive) of institutional factors influence how Green IS enables organisational capabilities to design and manufacture environmentally responsible products.	Case study	JSIS
Butler and Hackney (2021)	Institutional theory	How municipalities institutionalise a Green IS and the system, in turn, changes the behaviours of organisational members	Institutional and informational mechanisms that underpin the process of Green IS implementation and organisational behaviours change	Case study	I&M
Chan and Ma (2017)	Natural resource-based view Agency theory	The effects of executive compensation (i.e., CEO fixed pay, bonus, and stock option) and competitive intensity on IT-based environmental strategies (i.e., green IT strategies and IT-enabled green strategies)	CEO fixed pay and CEO bonus negatively impacts IT-based environmental strategies CEO stock option positively impacts these strategies Competitive intensity strengthens the positive effects of stock options on green IT strategies and IT-enabled green strategies Competitive intensity strengthens the negative effects of	Survey	EJIS

Paper	Theoretical foundation	Research focus	Key findings	Research method	Journal
			CEO fixed pay and bonus on IT-enabled green strategies.		
Cooper and Molla (2017)	Absorptive capacity	IS-environmental absorptive capabilities	Antecedents (i.e., sustainable IS exposure, IS prior experience, IS triggers) lead to IS-environmental absorptive capacity (i.e., sustainability knowledge acquisition, assimilation, transformation and exploitation) IS-environmental absorptive capacity results in IS outcomes and organisational performance in operational and market dimensions	Mixed method	ISJ
Corbett (2013)	Persuasive systems design theory	The design and implementation of green IS	Principles for designing and implementing carbon management systems that enable employees' ecologically responsible behaviours	Case study	JAIS
Corbett and Mellouli (2017)	N/A	IS solutions for improving driving water quality and green spaces in cities	A conceptual framework of how IS supports the interaction of activities in the political, sustainability and administrative area	Multiple case study	ISJ
Fridgen et al. (2016)	Real options theory	An IS artefact that can predict electricity price in real-time	A dynamic, real-time model to predict electricity price using real options theory	Design science	JAIS
Gholami et al. (2013)	Belief-action-outcome framework Institutional theory	The effects of institutional and individual factors on Green IS adoption	Institutional factors are positively associated with individual attitudes towards Green IS	Survey method	I&M

(Continues)

Paper	Theoretical foundation	Research focus	Key findings	Research method	Journal
			adoption, which ultimately leads to adoption actions; Green IS adoption is positively associated with environmental performance		
Hanelt et al. (2017)	N/A	The ways in which IS complements eco-innovations to improve eco-efficiency and eco-effectiveness	IS complements eco-innovations for sustainability in two ways: replacing or reducing human labor; enabling new functionalities, business processes, and business model	Multiple case study	ISJ
Hasan et al. (2017)	Activity theory	The role of IS in climate change adaption	Five interventions that impact an organisation's climate change adaptation	Action research	ISJ
Hedman and Henningsson (2016)	N/A	Organisational green IS responses	Organisational green IS champions influence sustainability processes via authorisation and edification; sustainability processes lead to transformation at the corporate level via value extension and reinforcement	Case study	ISJ
Hu et al. (2016)	Institutional theory; Competitive dynamics	Key drivers of a firm's green IT practices	Environmental-level (i.e., perceived public environmental awareness; government regulations), industry-level (i.e., industry norms; competitors' green practices), and firm-level factors (i.e., customers' and equity holders' attitudes and internal readiness) directly impact a	Survey	JMIS

Paper	Theoretical foundation	Research focus	Key findings	Research method	Journal
			firm's green IT practices Firm-level factors also mediate the effects of environmental-level and industry-level factors on green IT practices		
Loeser et al. (2017)	Beliefs-actions-outcomes framework	Organisational benefits of green IS strategies and practices	Organisational environmental orientation impacts their green IS strategies, leading to green IS practices that result in cost reduction, corporate reputation and green innovation capabilities	Survey	ISJ
Nishant et al. (2017)	Natural resource-based view Signalling theory	The business value of green IT announcements	Green IT announcements positively influence a firm's market value and such effects do not change across different levels of innovativeness of a firm	Event study	JAIS
Seidel et al. (2013)	Socio-technical systems Affordance theory	Sustainable business practices enabled by information systems	The material properties of information systems enable sensemaking affordances and sustainable practicing affordances that lead to environmentally responsible activities	Case study	MISQ
Seidel et al. (2018)	Affordance theory	Design principles for organisational environmental sustainability transformations.	Design principles that explain how IS can afford sense-making practices to achieve organisational transformation in environmental sustainability	Design science	EJIS

(Continues)

Paper	Theoretical foundation	Research focus	Key findings	Research method	Journal
Yang et al. (2019)	N/A	How the alignment between green supply chain system (GSCM) and green IS system (GIS) influences sustainability performance in economic, environmental, and social dimensions	The alignment moderates and mediates the effects of GSCM and GIS efforts on sustainability performance	Survey method	I&M
Zampou et al. (2022)	N/A	Energy and carbon management systems	A design theory for energy and carbon management systems	Design science research	JAIS
Zhang et al. (2022)	Resource orchestration	How to develop big data analytics capabilities to realise value for environmental sustainability	A process model that involves three stages (i.e., data resource orchestration, big data analytics capabilities development, big data value realisation)	Case study	I&M

APPENDIX 2: INTERVIEW PROTOCOL AND ARCHIVAL DATA

TABLE A1 Sample interview protocol for BankEx and GPT.

Topics	Questions
Sustainability position	1. What continuously motivates your organisation's sustainability journey? 2. How does your organisation define sustainability? 3. Who is involved in sustainability? (i.e., roles and departments and how they are positioned in the organisation) 4. What are the sustainable development goals at your firm?
Challenges of implementing initiatives	5. What would you identify as the three major challenges in achieving your sustainable development goals/targets? 6. How do you address these challenges? 7. Are there any additional resources/tools you require to enable your organisation to achieve your sustainability goals?
BA for sustainability	8. Can you tell me about data you work with on a regular basis, where it is sourced from, and who you interact with to use the data? 9. How is data and analytics helping your business make better decisions towards more sustainable performance? Could you provide any examples? 10. What are the challenges of generating insights, or diffusing this information through the organisation? 11. What are the external factors (e.g., policies, competition etc.) that affect the data-driven sustainability at your firm? 12. What are the next steps in developing your firm regarding sustainability?

TABLE A2 Sample interview protocol for Envizi.

Topics	Questions
Firm development	1. Can you please share with me the motivation for and the development process of the firm? 2. How has the recent emergence of the sustainability framework impacted your firm development?
BA software	3. Can you please explain the key functionalities of the firm's products? 4. Can you explain which areas of sustainability your products are most focussed on, and why? 5. Can you please explain how the use of digital technologies empowers your product?
Relationships with client firms	6. Can you tell me a little about the competitive advantage of your products compared with the competitor products? 7. Can you please outline 3 major issues or challenges that your firm has faced since you introduced the product to the client firm? How have you addressed them? 8. How does your firm maintain relationships with your client firms?

TABLE A3 Sample interview protocol for Energetics.

Topics	Questions
Firm background	1. Can you briefly explain the major services/products offered by your firm? 2. Could you describe your relationship with Envizi? 3. Could you describe your relationship with its clients? 4. What other external entities/partner organisations do you collaborate with on a regular basis? 5. What sort of market research do you undertake to give the best possible advice to clients?
Challenges to implementing initiatives for clients	6. What would you identify as three major challenges that your clients face for achieving sustainability? 7. How do you assist them with their strategic decision making to combat these challenges?
Using BA software	8. How does the use of data analytics enable your clients to become more environmentally sustainable on a day-to-day basis? 9. Are there any difficulties that your clients face when generating insights from the data? 10. What actions did you take to help them address the issues?
Client benefits and next steps	11. How has the product helped your clients to shape their competitive advantage or innovation in comparison with competitors/industry? 12. What are the organisational capabilities/resources that successful clients possess that enable them to be leaders in the sustainability space? 13. What are your next steps in developing your firm, and your working relationship with Envizi?

TABLE A4 Archival data at BankEx and GPT.

Firm	Archival ID	Document Type
BankEx	AB1	Sustainability report
	AB2	Annual report
	AB3	Environmental and social sustainability report
	AB4	Carbon disclosure report
	AB5	Media article – named most sustainable firm in 2017
	AB6	Media article – named most sustainable firm in 2018
GPT	AP1	Annual report
	AP2	Climate disclosure report
	AP3	Climate change and energy policy
	AP4	Environmental, social, and governance report
	AP5	Sustainability report
	AP6	Business report on waste management
	AP7	Media article – building energy performance overview

APPENDIX 3: PARTICIPANT INFORMATION

Firm	Participant ID	Participant role
BankEx	PB1	Senior manager, Climate Change & Corporate Responsibility
	PB2	Manager, Energy & Sustainability
	PB3	Analyst, Energy & Sustainability
	PB4	Manager, Corporate Responsibility
	PB5	Executive Manager, Community Investment
GPT	PG1	Head, Sustainability & Energy
	PG2	National Manager, Building Performance
	PG3	Building Performance Analyst
	PG4	Manager, National Social Sustainability
Envizi	PE1	CEO and Co-Founder
	PE2	Partner Manager
	PE3	Product Manager (D)
	PE4	Product Manager (S)
	PE5	Technical Advisor
Energetics	PC1	Executive Director
	PC2	General Manager in Energy Consulting
	PC3	Principal Consultant in Energy and Carbon Markets
	PC4	Manager in Energy Accounting

APPENDIX 4: ILLUSTRATION OF CODING

In this section, we explain a series of techniques that we use to establish the reliability of our data analysis. First, we develop a scheme to guide our coding. Table A5 presents the coding scheme in terms of definitions of theoretical concepts of BA-powered ambidexterity and the descriptive codes for each concept. Second, we demonstrate how we develop the BA-powered ambidexterity mechanisms and their associated outcomes using coding examples, see Table A6.

TABLE A5 Coding scheme for BA-powered ambidextrous sustainability practices.

Concepts of BA-powered ambidexterity	Meaning	Descriptive codes for ambidextrous sustainability practices
Data availability-powered contextual ambidexterity	The ability to foster organisational members' ambidextrous behaviours, augmented by the availability of consistent environmental data for sustainability-related decision-making	• Using BA to automate the process of uploading environmental data • Using BA to visualise data for reporting sustainability performance • Using BA to improve data consistency
Data timeliness-powered contextual ambidexterity	The ability to foster organisational members' ambidextrous behaviours, augmented by the timeliness of environmental data for sustainability-related decision-making	• Using real-time analytics to monitor sustainability performance • Generating alerts for environmental anomalies
Data-driven culture-powered contextual ambidexterity	The ability to shape organisational members' ambidextrous behaviours and attitudes, augmented by employees' shared beliefs of using data to change their sustainability practices for both short-term and long-term impacts	• Making data-driven sustainability decisions • Being flexible in using data to experiment with different sustainability approaches • Data enable paradigm shifts in the sustainability mindset
Holistic insights-powered structural ambidexterity	The ability to conduct simultaneous sustainability exploration and exploitation augmented by analytical insights that provide a holistic view for inter- and intra-organisation collaboration	• Integrating organisation-wide sustainability data for cross-function collaboration • Sharing sustainability data across organisations for collaboration
Analytics leadership-powered structural ambidexterity	The ability to simultaneously explore and exploit sustainability knowledge augmented by leaders' initiatives to drive the use of BA at organisation and ecosystem levels	• Promoting inter- and intra-organisational analytics orientation • Championing analytics-driven sustainability initiatives • Institutionalising business processes for analytics decision-making

TABLE A6 Coding examples for BA-powered ambidexterity mechanisms.

Mechanisms: Definition	Sustainability practices: Interview/archival data (key phrases in bold)	Outcomes
BA-powered context shaping mechanism: the process through which data availability, timeliness, and data-driven culture foster an organisational context that allows employees to flexibly engage in sustainable exploration–exploitation activities.	Data availability-powered contextual ambidexterity: But **with the use of Envizi, a lot of the sustainability reporting has been done more frequently**… because of that… higher executives are just a lot more aware of what's happening on the sustainability front. And that allowed them to **make more prompt decisions regarding some of the sustainability opportunities out there for the group**. – Energy and Sustainability Analyst, BankEx	Eco-efficiency
	Data timeliness-powered contextual ambidexterity: Implementing a demand response programme at many of our assets **to utilise onsite electricity generation infrastructure and actively manage electricity loads throughout the day**… BuildingEx [GPT's first office building] generates renewable electricity onsite and participates in a real-time demand response programme that **optimises the building's energy consumption in response to peak demand events [Outcome: Eco-efficiency], reducing demand charges and the building's impact on the wider electricity network**. – Page 19, Archival Data No. AP5	• Eco-efficiency • Eco-effectiveness
	Data-driven culture-powered contextual ambidexterity: Shifting… we are custodians, not actually the generators of this material. So getting the buy-in from our tenants and looking at what we buy, not just what is wasted …**So the real trick is going to be, how do we get that measurement of the materials in the first place?… when you measure that, go well, we need to look at the other side of the equation, what we buy, not just what we manage through a waste contract**. – Head of Sustainability and Energy, GPT	Eco-awareness
BA-powered resource linking mechanism: the process through which analytics insights and leadership facilitate the integration of resources across internal and external structural units for sustainable exploration–exploitation activities.	Holistic insights-powered structural ambidexterity: I guess our value-adding is that we **consolidate those data into more user-friendly reports**. We consolidate it into the site, summing it up to like site usage and then presenting it to them [BankEx], sort of like charts so that they can easily see the trends… for us, it's more of like the day-to-day managing of their data … **they can also monitor like how much usage they have and [understand] how much they need to offset with that power usage agreement**. – Energy Accounting Manager, Energetics	Eco-effectiveness
	Analytics leadership-powered structural ambidexterity: **So we meet, you know, at least quarterly. Last week, we had a discussion with the three parties [BankEx, Energetics, and Envizi]**… So we are saying, look, we do our annual report, we do DJSI (Dow Jones Sustainability Indices), CDP (Carbon Disclosure Project)… etc. And they all need slightly different reports. How can we possibly use Envizi's PowerBI function? **So we have been meeting to see how we can optimise some of the reporting, or streamline it**. – Energy & Sustainability Manager, BankEx	Eco-efficiency