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Sachithra Lokuge
College of Business and Law RMIT University, Australia

Darshana Sedera
Digital Enterprise Lab Southern Cross University, Australia

Vanessa Cooper
College of Business and Law RMIT University, Australia

Frada Burstein
Faculty of Information technology Monash University, Australia

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Sachithra Lokuge
College of Business and Law
RMIT University, Australia

Darshana Sedera
Digital Enterprise Lab
Southern Cross University, Australia

Vanessa Cooper
College of Business and Law
RMIT University, Australia

Frada Burstein
Faculty of Information technology
Monash University, Australia

Abstract:

The advent of digital technologies such as social media, mobile, analytics, cloud computing, and the Internet of things has provided unique opportunities for organizations to engage in affordable, easy-to-use, easy-to-learn, and easy-to-implement innovations. Transformations through such technologies often have positive impacts on business processes, products, and services. As such, organizations have managed to increase productivity and efficiency, reduce cycle time, and make substantial gains through digital transformation. Research has also found such transformations to be positively associated with reducing harmful environmental impacts by providing organizations alternative ways to conduct their business activities. However, in recent times when organizations can use many technologies at near-zero cost, questions regarding the potential negative impacts that digital transformation has on the environment have arisen. The contemporary ubiquitous technologies that pervade everyday life necessitate that organizations continue to create large data centers that increase in capacity daily; however, such growth also increases their impact on the environment. Considering this dialectical contradiction, in 2019, we conducted a panel at the Australasian Conference on Information Systems (ACIS) in Perth, Australia, to invigorate the dialogue regarding the impact that digital transformation has on environmental sustainability and investigate some directions for future research in this area.

Keywords: Digital Transformation, Environmental Sustainability, Decision-Making, IT Capabilities, IT Business Alignment.

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1 Introduction

Over the past three decades, organizations have become better aware of environmental sustainability (Hanelt, Busse, & Kolbe, 2016). Climate change has featured prominently in the Global Risk Report for the past five years, which highlights the risk that it has on individuals and the planet (World Economic Forum, 2016). According to World Bank reports, without urgent action to reduce environmental pollution, climate change could push an additional 100 million people into poverty by 2030 (The World Bank, 2019). Climate change proponents seek stronger legislation and government intervention to deter pollutant organizations and countries. Moreover, societal pressures have forced organizations to introduce corporate social responsibility strategies that facilitate environmental sustainability (Rush, Melville, Ramirez, & Kobelsky, 2015). However, environmental sustainability initiatives often fail due to lack of stakeholder awareness, lack of employee participation, lack of accountability in the process, inability to integrate performance outcomes, process complexity, and the difficulty in initiating and managing such initiatives (Sedera, Lokuge, Tushi, & Tan, 2017).

Technology plays an important role in initiating and managing environmental sustainability. On one side, the advent of social media, mobile, analytics, cloud computing, and the Internet of things (IoT) has provided unique opportunities for organizations to engage in affordable, easy-to-use, easy-to-learn, and easy-to-implement environmental sustainability initiatives (El-Kassar & Singh, 2019; Sedera & Lokuge, 2017). Transformations through technologies often have positive impacts on business processes, products, and services (Lokuge, Sedera, Grover, & Xu, 2019; Majchrzak, Markus, & Wareham, 2016; Sedera, Lokuge, Grover, Sarker, & Sarker, 2016). Furthermore, these technologies support environmental sustainability in helping organizations obtain accurate and actionable data through the IoT and sensors, create awareness and seek collaborations through social media, develop better prediction models through business intelligence, and deploy solutions through affordable mobile solutions. Indirectly, digital transformation initiatives assist environmental sustainability through supporting better logistics and supply chain management solutions that reduce carbon footprints, supporting better waste-management solutions, and minimizing manufacturing requirements through three-dimensional printing. Over time, advancements in digital technologies seem to have softened the burden that organizations face in balancing economic gains and environmental sustainability (Sui & Rejeski, 2002). However, given that organizations today can acquire many technologies at near-zero costs, questions have arisen about the potential negative impact that digital transformation may have on the environment (Bieser & Hilty, 2018). The many ubiquitous technologies that pervade everyday life today necessitate that organizations continue to create large data centers that increase in capacity daily; however, such growth also increases their impact on the environment. For example, Andrae and Edler (2015) have predicted that, by 2030, data-center electricity use will likely increase about 15-fold to eight percent of the projected global demand for electricity. Furthermore, various sources have called out initiatives such as Bitcoin for causing a substantial increase in energy use (Jones, 2018).

Considering this debate surrounding technology's impact on the environment, we conducted a panel in 2019 at the Australasian Conference on Information Systems (ACIS) in Perth, Australia, to stimulate the dialogue regarding the impact that digital transformation has on environmental sustainability. Despite much literature on digital transformation and environmental sustainability, we lack research that examines the impact that digital transformation has on environmental sustainability. Both researchers and practitioners need to discuss the theoretical, conceptual, and practical notions of environmental sustainability and digital transformation. The panel provided future directions in managing and achieving environmental sustainability goals in digital transformation initiatives. In this paper, we summarize the panel. Darshana Sedera chaired and moderated the panel, while Frada Burstein, Vanessa Cooper, and Sachithra Lokuge took part as panelists.

This paper proceeds as follows: in Section 2, we discuss the importance of sustainability in digital transformation. In Section 3, we highlight how organizations can focus on aligning environmental sustainability in strategic digital transformation initiatives. In Section 4, we focus on capabilities required for environmentally sustainable digital transformation initiatives. In Section 5, we highlight how environmental sustainability can be incorporated in decision making process. Finally, in Section 6, we provide a framework for environmentally sustainable digital transformation initiatives and future research ideas for environmental sustainability and digital transformation.

2 Why Environmental Sustainability is Important in Digital Transformation? An Overview

The advent of digital technologies such as social media, mobile, analytics, cloud and the IoT has enabled digital transformation, a phenomenon that academics (Bieser & Hilty 2018; Li, Su, Zhang, & Mao, 2018; Lokuge & Sedera, 2016; Sedera & Lokuge, 2019; Vial, 2019) and practitioners (Forbes, 2016; Haffke, Kalgovas, & Benlian, 2016) have paid much attention to. Vial (2019, p. 118) defines digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies". As per Wessel, Baiyere, Ologeanu-Taddei, Cha, and Jensen (2020), digital transformation differs from an IT strategic initiative because, in digital transformations, digital technology plays a central role in redefining value propositions, which triggers a new organizational identity to emerge. The transformed organizational identity provides positive changes including enhanced decision-making capabilities (Brynjolfsson, 2011; Huber, 1990), redefined value propositions (Wessel et al., 2020), increased customer connectedness (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; Kumar et al., 2010), expanded channels for reaching customers/suppliers (Bharadwaj, 2000; Kleis, Chwelos, Ramirez, & Cockburn, 2012), and enhanced communication facilities (Olesen & Myers, 1999; Youmans & York, 2012). However, Sedera highlighted that, despite their advantages, digital technologies also have negative impacts in organizations (e.g., increased carbon footprint, increased wastage, and damage to the environment), which organizations do not always consider. Thus, we need to highlight the urgent need to consider environmental sustainability in digital transformation initiatives.

The World Commission on Environment Development (1987) defines sustainability as "development that meets the needs of the present without compromising the ability of future generations to meet their needs". We need to discuss environmental sustainability given that digitalization has become contemporary organizations' number one priority. Hence, while initiating digital transformation projects, organizations need to incorporate environmental sustainability aspects. As a result, scholars continue to discuss importance of environmental sustainability in strategic initiatives for digitalization. The panel acknowledged the two relationships between environmental sustainability and digital transformation: 1) environmental sustainability through IT and 2) environmentally sustainable IT.

Environmental sustainability through IT focuses more on making production processes greener. It focuses on applying more environmentally sustainable practices using IT (e.g., introducing software to measure employees' carbon emissions). Such IT initiatives have made employees mindful about their role in achieving environmentally sustainable work practices. On the other hand, environmentally sustainable IT focuses on making IT itself greener. For example, environmentally sustainable IT focuses on green data centers, reductions in greenhouse gas emissions, and so on. The panel focused on the first relationship (i.e., environmental sustainability through digital transformation) since it pertains to all organizations despite their size, industry sector, and resourcefulness.

In some countries, government initiatives mandate that organizations adhere to environmental sustainability and green management practices. For example, in Australia, regulations such as Australian Environment Protection and Biodiversity Conservation Act 1999 provide a legal framework to protect and manage all matters related to national environmental significance. Many organizations perceive environmental sustainability and green management as a "responsibility" or as a "compliance" issue rather than an opportunity. As such, most organizations view a typical environmental sustainability management initiative as a cost. Therefore, such initiatives fail to gain traction with key stakeholders and wither without achieving the proposed environmental effects. Moreover, the "cost" perspective fails to make such initiatives valuable to the organization. However, several real-world cases highlight the importance and the value of following environmentally sustainable practices in an organization. For example, Good Guys Capalaba (in Australia)—a franchised white goods store—initiated an in-store polystyrene recycling program to make coat hangers and picture frames, which reduced the store's carbon footprint tremendously. Moreover, this initiative reduced approximately five tons of waste from Australian landfill annually (Tsirimokos, 2011).

Research suggests that sustainability initiatives present an opportunity for an organization to think outside the box (Du, Bhattacharya, & Sen, 2007; Hong, Yang, & Rim, 2010; Tushi, Sedera, & Recker, 2014). For example, evidence shows that, in the airline and tourism sectors, customers will pay an extra premium for sustainable-labeled products or services. Moreover, governments have implemented substantial initiatives to provide incentives for sustainability programs. Al-Saleh and Mahroum (2015) observed the association

between sustainability policies and how organizations respond to such changes. Moreover, studies have also reported that a focus on environmental sustainability has led organizations to reduce their operational costs in the long run (Ambec & Lanoie, 2008). Organizations that proactively follow environmentally sustainable practices have a higher chance to gain external support from governments, non-government organizations, and the general public as they prioritize the environmental concerns (Luo & Du, 2012).

Sedera commenced the panel and argued that, for both academics and practitioners, environmental sustainability should not be an afterthought or an obligation but rather a central component in organizational strategy. Using the IT-business strategic alignment model (SAM) (Henderson and Venkatraman 1993) to propose the panel's basis, Sedera suggested that environmental sustainability could be the deciding factor in whether business strategy, IT strategy, business, and IT processes leads to a competitive advantage. Though environmental sustainability constitutes a key factor that drives the contemporary business landscape, the SAM fails to capture environmental sustainability's importance. Prior researchers have investigated IT alignment from multiple perspectives, such as alignment between business strategy and IT strategy (Chan, Sabherwal, & Thatcher, 2006), business strategy and IT capabilities (McLaren, Head, Yuan, & Chan, 2011), and IT business alignment in multi-business organizations (Queiroz, Coltman, Tallon, Sharma, & Reynolds, 2018). However, researchers have rarely considered environmental sustainability as a key component in SAM.

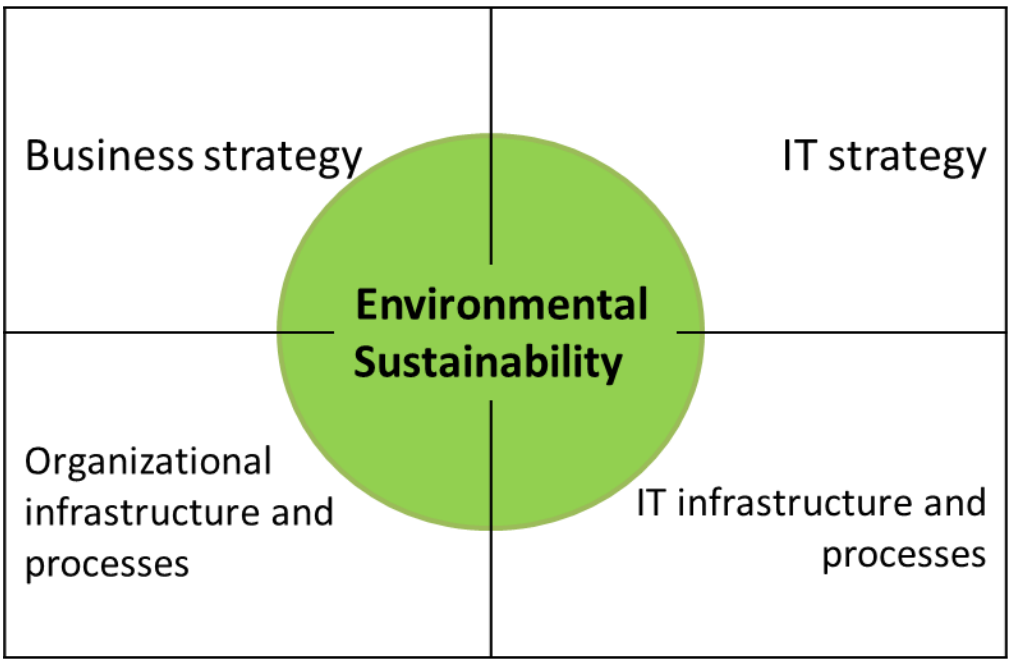

Figure 1. Proposed Sustainable Strategic Alignment Model

Keeping environmental sustainability as the core, the remaining panelists contributed to the discussion in the following manner. First, Lokuge extended the notion of the environmental sustainability as central in the IT-business strategic alignment model by proposing an updated model for strategic alignment model with sustainability as the central component. Second, Cooper discussed the capabilities organizations require to ensure environmentally sustainable digital transformations. In doing so, she emphasized the importance of developing capabilities to assess whether a digital transformation will have a positive and/or negative impact on environmental sustainability in the first instance. Third, Burstein discussed the strategic decision-making process in relation to orchestrating organizational and IT infrastructure and processes to yield an environmentally sustainable practice.

3 Alignment of Digital Transformation Initiatives to Environmental Sustainability

Following the central theme that Sedera suggested, Lokuge further explained ways to incorporate environmental sustainability in extending the cross-domain perspectives that Henderson and

Venkatraman (1993) introduced. In IT-business alignment, alignment refers to the degree to which IT concurs with business according to their needs, demands, goals, objectives, and/or structures (Gerow, Grover, Thatcher, & Roth, 2014; Gerow, Thatcher, & Grover, 2015). According to Henderson and Venkatraman (1993), organizations should align IT strategy, business strategy, business infrastructure and processes, and IT infrastructure and processes to harvest the full potential of their IT strategic initiatives. Further, when commencing digital transformation projects, organizations should ensure they incorporate environmental sustainability into every aspect from planning to execution. In Table 1, we summarize what Lokuge suggested as examples where organizations can incorporate environmental sustainability into strategic alignment model.

Table 1. Examples for Enhanced Sustainable Strategic Alignment Model (SAM)

SAM component	SAM subcomponent	Examples of relevant environmental sustainability factors
Business Strategy	Business scope	Sustainability hackathons to identify opportunities and business areas. Reevaluating products and services to incorporate sustainability. Integrated thinking to minimize the impact on the environment. Incorporating sustainable development goals. Corporate social responsibility goals. Promoting green vendors.
	Distinctive competencies	Identifying the strengths, weaknesses, opportunities, and threats in terms of sustainability. Improving employees' green awareness. Introducing sustainability concepts to the competent business areas. Introducing a green team to develop and implement sustainable solutions. Eco-branding. Environmental stewardships.
	Business governance	Introducing compliance, governance structures, standards, frameworks, and structures to promote sustainability in work practices. Introducing environmental sustainability aspects for strategic initiatives.
IT Strategy	Technology scope	Green hackathons to identify the best technological solutions that incorporates sustainability. Promoting the use of sustainable technologies. Introducing mandatory guidelines for environment pollution management.
	Systematic competencies	Competence in using sustainable IT solutions. Sustainable IS knowledge. Skills framework for the information age.
	IT governance	Managing high carbon-emitting IT tools in a centralized manner. Governance structures based on the carbon footprint. Guidelines and framework for new sustainable initiatives. Introducing carbon emission management plan for technologies.
Organizational infrastructure and processes	Administrative infrastructure	Incentivizing individuals to promote sustainable behaviors. Green IT outsourcing based on carbon emission. Waste management. Optimizing resource usage.
	Processes	Greening all operational activities such as accounting, marketing, supply chain, production, and so on. Introducing green/sustainability component to performance reviews.
	Skills	Introducing training sessions to improve employees' knowledge on sustainability practices. Promote obtaining certifications for sustainable practices.
IT infrastructure and processes	Architecture	Minimizing wastage. Using sustainable IT solutions. Reusing IT. Managing waste. Optimizing resource usage. Recycling assets.
	Processes	Green business process management. Sustainability concepts in the automation process. Green supply chain management.
	Skills	Introducing green challenges to increase awareness of sustainable initiatives. Compliance leadership.

As per Wessel et al. (2020), digital transformation refers to a strategic initiative in an organization. Lokuge argued that organizations need to maintain IT-business alignment for digital transformation projects to succeed. When IT-business alignment model components align well in an organization, it will likely invest in IT and, thereby, create a sustainable competitive advantage (Lokuge & Sedera, 2019, 2020; Sabherwal & Chan, 2001). However, in such strategic initiatives, organizations rarely consider environmental sustainability as an important factor. Most organizations focus solely on profit rather long-term environmental sustainability gains.

Considering the literature on IT-business alignment, Lokuge argued that one can hypothesize four dominant alignment perspectives for attaining environmental sustainability, which we show in Figure 2. We identified the four alignment perspectives based on the leading component. As per Figure 2, we propose business strategy and the IT strategy as catalysts in determining alignment perspectives.

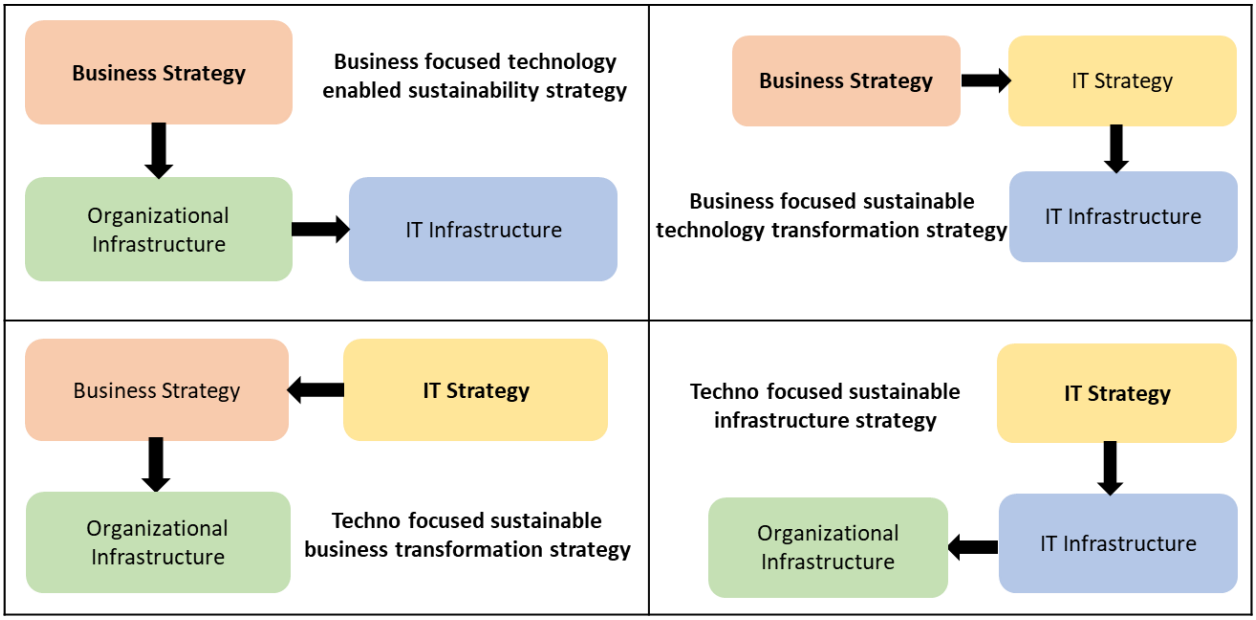

Figure 2. Four Alignment Perspectives for Attaining Environmental Sustainability

Business-focused technology-enabled sustainability strategy: this business strategy has environmental sustainability at its core and leads to a greener digital transformation execution. The strategic decision makers play a key role in leading the environmental sustainability discussion in this perspective. Executives should recognize the need to include sustainability in strategy formation.

Business-focused sustainable technology transformation strategy: this business strategy has environmental sustainability at its core, which drives the digital transformation to be greener. In this approach, organizations incorporate sustainable IT solutions for their digital transformation initiatives.

Techno-focused sustainable business transformation strategy: this IT strategy promotes green digital transformation, which makes an organization's processes, tools, and infrastructure greener. In this approach too, the strategic decision makers play a key role in leading the environmental sustainability discussion.

Techno-focused sustainable infrastructure strategy: this IT strategy drives discussions about environmental sustainability in an organization. Further, this strategy represents a sustainable IT movement as it makes both IT infrastructure and administration infrastructure greener. As such, one could argue that this strategy has a higher green impact compared to the other strategies.

4 Capabilities for Environmentally Sustainable Digital Transformation

Cooper focused on the need for organizations to develop their capabilities to ensure that digital transformation has a positive impact on environmental sustainability. Picking up on Sedera's introduction, Cooper highlighted the impact that IT has on the environment. She emphasized that IT does not always have a straightforward impact on the environment. For example, although users may have the best intentions in using digital rather than printed reports, an increase in energy consumption may offset the reduction in paper consumption if the substitution results in users repeatedly downloading reports. For example, how often do people check their bank account balances now that they can do so online compared to when they had to call or visit the bank? We need to investigate how IT changes behavior and what impact such behavioral changes have because the environment may suffer in cases where IT makes behaviors easier. In order to determine whether digital transformation represents an environmental friend or foe, researchers need to more accurately measure the environmental impact that IT has. Cooper illustrated this point in discussing a controversial article in the *Sunday Times* a decade ago that reported how two Google searches produced the same amount of CO_2 as boiling a kettle (a report that Google and the lead researcher cited in the article, Alex Wissner-Gross, later scrutinized) (Kincaid, 2009; Miguel, 2009). Cooper also used examples to highlight the complexity of measuring the impact that digital transformation has on the environment (Bieser & Hilty, 2018) and the need for organizations to develop

their capabilities to not only measure this impact but to ensure that digital transformations have a positive rather than negative impact on environmental outcomes (Bieser & Hilty, 2018; Hanelt, Busse, & Kolbe, 2017).

When focusing on environmentally sustainable digital transformation, an organization's IT capabilities play an important role. We define IT capability as "the firm's ability to mobilize and deploy its IT-based resources, creating value in combination with other resources and capabilities (Bharadwaj, 2000, p. 171) and the firm-specific IT enabled knowledge and routines that improve the value of non-IT resources" (Drnevich & Croson, 2013, p. 485). As such, in her presentation, Cooper turned to considering the capabilities that organizations require for digital transformation and for environmental sustainability.

4.1 Capability and Digital Transformation

In the digital age, technology increasingly lies at the center of how organizations produce value, generate income, and realize competitive advantage. Recent advances in digital technology, platforms and ecosystems (Vial, 2019) have extended how widely and deeply IT impacts organizations (Lokuge & Sedera, 2018). Customers increasingly demand personalized and seamless multi-channel experiences. Rather than simply automating existing business processes, digital transformation changes an organization's digital identity (Lokuge & Sedera, 2014a, 2014b; Wessel et al., 2020). Under such conditions, organizations require distinct capabilities.

Both researchers and practitioners have reported that today's organizations increasingly require capabilities for developing digital strategy (Lopez, 2014), digital customer engagement (Catlin et al. 2015), digital leadership and technology (Lokuge, Sedera, & Perera, 2018; Lopez, 2014), modular IT platforms/platform use (Catlin, Scanlan, & Willmott, 2015; Li et al., 2018), agile technology-delivery skills (Catlin et al., 2015; Walther et al., 2018), dynamic managerial capabilities (Li et al., 2018), business development capabilities (Li et al., 2018), IT human resource capability, and new service delivery capabilities (Aral & Weill, 2007; Singh, Mathiassen, Stachura, & Astapova, 2011; Walther et al., 2015). Dynamic capabilities—a firm's "ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece, Pisano, & Shuen, 1997)—remain central to digital transformation. Cooper highlighted the role that external organizations (e.g., platform providers) play in digital transformation given the complex business eco-systems in which digital transformation occurs (Li et al., 2018). Accordingly, for digital transformation, the question for those interested in environmental sustainability is "what capabilities are required by organizations to ensure digital transformations have a positive rather than negative impact on the environment?".

4.2 Capabilities for Environmental Sustainability and Digital Transformation

Despite a growing body of literature on green IS (Corbett, 2013; Watson, Boudreau, & Chen, 2010), relatively little attention has been given to the specific capabilities that organizations require to leverage IS for environmentally driven digital transformations (for exceptions, see Bose & Luo, 2011; Cooper & Molla, 2017; Molla, Cooper, & Pittayachawan, 2011). For organizations to ensure that digital transformations deliver environmentally sustainable outcomes, they must embed environmental sustainability in their IS infrastructure and practices (Hu, Hu, Wei, & Hsu, 2016; Melville, 2010) and develop IS innovations that provide environmental benefits (El-Kassar & Singh, 2019; Sui & Rejeski, 2002; Venable et al., 2011). Developing green IS capability constitutes a specific and complex organizational competence that differs from developing IS capability for conventional business outcomes. While the processes that organizations need to develop capability in green IS and IS capability in other contexts overlap, IS practitioners should pay careful attention to the differences.

Organizations should not assume that IS professionals alone can address environmental sustainability challenges with their traditional knowledge and skills as these challenges constitute relatively new concerns for them. IS professionals require sustainable IS knowledge, which includes the IS strategy, solution, and evaluation principles for environmental sustainability (Cooper & Molla, 2017). IS educators and professional associations should ensure that they incorporate environmental sustainability topics into IS curricula (Sendall, Shannon, Peslak, & Saulnier, 2011; Watson et al., 2010). For example, as Lokuge discussed, environmental sustainability introduces a distinctive dimension to the IT-business alignment equation and requires IS professionals and IS departments to extend their traditional knowledgebase and skillsets to develop new capabilities. Frameworks such as the skills framework for the information age (SFIA) offer important guidelines to academics and practitioners. Not until this framework's fourth iteration did it include sustainability skills (sustainability strategy, sustainability management, sustainability

assessment and sustainability engineering). The most recent and seventh iteration merged these skills with more traditional IS skills. While the underlying assumption that various skill areas cover sustainability skills may represent an ideal scenario, Cooper argued that this assumption has its risks. For example, organizations may more easily overlook sustainability skills. Like many other IS phenomena, the factors that facilitate and inhibit green IS capability development need careful attention since the environmental sustainability context warrants some unique considerations. First, unlike market-based resources and capabilities, maximizing green IS capability outcomes depends on diffusion; that is, organizations should share their knowledge and collaborate so that they can collectively address environmental issues (Cooper & Molla, 2017). Thus, traditional market forces may produce some nuanced results in this context. Second, when organizations view green IS as a trade-off with core responsibility areas (e.g., security, risk management, customer service), they may deprioritize green IS, and, thus, the factors that facilitate and inhibit green IS capability may have less influence.

To evidence these points, Cooper elaborated on a study she undertook with a co-author in which they investigated IS absorptive capacity for environmentally driven IS-enabled transformation (Cooper & Molla, 2017). Through surveying 148 senior IS managers, they developed a model that explained that IS triggers, knowledge exposure, and prior experience influence whether organizations develop IS-environmental absorptive capacity, which, in turn, contributes to how significantly organizations assimilate environmentally sustainable IS and save costs and to their operational performance and reputation. The case study results emphasized the importance of contextual factors at the IS department and organizational levels. For example, at the IS department level, the study highlighted that participants viewed the IS department's role as delivering projects requested at the organizational level rather than as a thought leader. Furthermore, the study also found that, without clear sustainability commitment, sustainability performance indicators, or sustainability championship at the organizational level, organizations would lack the ability to develop IS absorptive capacity for environmentally driven IS-enabled transformation. While these findings may be unsurprising, they indicate some significant challenges that face organizations that want to seriously ensure they implement environmentally sustainable digital transformations and the capabilities that the organizations must develop to overcome such challenges.

Leveraging IS for environmental sustainability should ultimately result in bettering the environment. Returning to whether digital transformation represents an environmental friend or foe, note that environmental outcomes have ambiguous causes, and one cannot always easily decide what to measure in the first instance. Indeed, stakeholder groups differ in their views about what constitutes desirable environmental outcomes and metrics (Cooper & Molla, 2017). Furthermore, these and other issues' complexity requires organizations to develop their capabilities in green IS and IS researchers should also contribute to developing knowledge in this area.

5 Integrating Environmental Sustainability in IT Decision-Making Process

Burstein contributed to the panel by discussing the opportunities and issues that organizations face in strategizing and decision-making processes in attaining environmental sustainability. She based her discussion on three main components in the decision-making process; namely, data, decision maker, and the decision-making process. The extant literature investigates technical aspects such as integrating lifecycle assessments to costing systems (Tsai et al., 2015), green decision-making models to logistics (Vahabzadeh, Asiaei, & Zailani, 2015), and tools for optimizing green building features (Ewing & Baker, 2009). Burstein highlighted that, as IS researchers, we seldom extend research to enhance capabilities to improve decision-making process regarding attaining environmental sustainability. In addition, the extant research fails to incorporate and investigate the impact of digital technologies and their relevance to strategic decision-making regarding environmental sustainability initiatives. In a time like this, we believe that we need to discuss how organizations could incorporate novel practices that favor green decision making.

Burstein commenced by reminding the panel participants about the wealth of opportunities that digital technologies such as social media, mobile technologies, analytics, and the IoT have provided to organizations due to the data they provide (Nylén & Holmström, 2015). For example, organizations have opportunities to seamlessly gather data about customers, products, business processes, and services. Decision makers can then process such data to make effective and informed decisions with an emphasis

on sustainability (Lokuge, Sedera, Ariyachandra, Kumar, & Ravi, 2020). However, organizations often use this continuous, rich, and voluminous data to obtain strategizing opportunities rather than to gain insights into environmental sustainability initiatives. Managers (decision makers) must focus on capturing not only data necessary for financial profitability but also data that concerns environmental perspective.

In addition to their traditional tasks, decision makers now also need to take leadership in their organizations to attain sustainability goals (Joshi, Kathuria, & Porth, 2003; Kim, Kim, & Kwon, 2020). Due to constant pressures from customers (Lieb & Lieb, 2010), environmental groups (McKinnon, 2010a), public policies (McKinnon, 2010b), and global mandates (Turnhout, Dewulf, & Hulme, 2016), organizations feel compelled to adhere to environmentally sustainable business operations without compromising their profitability and efficiency. Decision makers have traditionally followed approaches such as lifecycle assessment and net present value to assess decision outcomes' "greenness" (Melville & Zik, 2016). However, Burstein noted that such retrospective thinking in decision making rarely favors environmental sustainability. In particular, middle level and line-of-business managers are less likely to initiate environmental sustainability programs at the expense of compromising efficiency and profitability (Kim et al., 2020). For environmentally sustainable projects to be effective, such directives and support must come from executive-level managers (de Medeiros, Ribeiro, & Cortimiglia, 2014) incorporating assurances, support, and incentives into the organizational policy and procedures (Molla & Abareshi, 2012). Once top managers support corporate environmental sustainability and entrench it in policy and procedures, the line-of-business managers can then initiate, fine-tune, and manage their sustainability initiatives. Including clear parameters for looking at relevant sustainability data should be the new normal when formulating strategic decisions.

Along a similar vein, Burstein discussed the need to conduct design science research in integrating environmental sustainability to decision-making processes and proposed appropriate decision support systems designs, which include sustainability as one design principle. Prior research (e.g., Seidel, Chandra Kruse, Székely, Gau, & Stieger, 2018) has also proposed design principles for IS that support organizational sensemaking in environmental sustainability transformations. Degirmenci and Recker (2016) investigated how system users' actual behaviors and decisions can factually be environmentally sustainable through information systems. Further, Melville and Zik (2016) applied design science research to propose an energy productivity approach based on source energy and a new metric called energy points. While prior researchers have initiated a discussion around applying design science research in environmental sustainability, finding answers to such problems requires a rethink of the approach. By applying the systematic research gap analysis approach (Fielt, Bandara, Miskon, & Gable, 2014), Burstein discussed how organizations can incorporate sustainability into the decision-making process, this process's importance, the impact it has on them, and its critical success factors. For example, from the exploration phase, explicitly stating the need and importance to consider environmental sustainability will make sustainability initiatives a success. She suggested that we urgently need conceptual clarity around relevant classical "what/why/who/how" questions. Specifically, such efforts would target:

- What: what is the objective? What do we have? What do we need? What are the problems that need urgent attention?
- Why: why do we need to initiate this? Why is this necessary at this point?
- Who: who participates in making decisions about digital transformations?
- How: how should organizations adjust decision-making processes (existing and proposed) to reflect the concepts above.

The decision-making process constitutes a critical step in digital transformation projects. As we discuss above, the decision maker, the data/information available for making the decision, and the problem that requires attention all affect the decision making process. When introducing and incorporating environmental sustainability into the decision-making process, organizations need to consider all three components. For example, knowing about green initiatives may influence decision makers to incorporate green concepts in the decision-making process. While digital technologies have opened new ways for organizations to collect data, organizations have failed to fully incorporate big data for strategic decision making. Contemporary research focuses on applying big data concepts to market intelligence, e-governance, health, and security areas. In addition, researchers can apply big data to assess future initiatives' greenness. As Melville and Zik (2016) have proposed, organizations can collect large data sets on environmental metrics to analyze and derive new metrics related to environmental sustainability. As such, researchers could derive new approaches to compare different types of energy and sustainability

projects to better understand and model decision-making situations. Further, when looking at decisions to initiate strategies, decision makers could consider environmentally sustainable solutions. While all these suggestions may seem like a distant possibility, organizational decision makers need to prioritize environmental sustainability now as they will have no business without a planet.

6 Conclusion

Digital technologies have provided myriad avenues for organizations to transform their businesses. As such, in recent times, terms such as digitization, digitalization, and digital transformation have become buzzwords in both academia and practice. While such terms are associated with organizational performance, efficiency, and productivity, scholars have increasingly raised concerns about the impact that digital transformation has on environmental sustainability. In this panel, we discussed the need to develop an integrated view that aligns sustainability with digital transformation. We acknowledged that scholars generally understand that technologies will inevitably increase energy consumption and, thus, e-wastage and carbon emissions (Guster, Hemminger, & Krzenski, 2009; Sedera et al., 2017). Furthermore, research shows that technology initiatives incur great stress on the environment (Fuchs, 2008). Accordingly, researchers and practitioners need to look for ways to respond to the growing environmental sustainability issue (Wang, Brooks, & Sarker, 2015). As a result, organizations have experienced considerable global, local, and social pressure to initiate environmentally sustainable initiatives to minimize the negative impact that IT has on the environment (Nishant, Teo, Goh, & Krishnan, 2012). To minimize this pressure, some organizations employ IT to promote sustainability (Hasan, Ghose, & Spedding, 2009) and some organizations utilize environmentally sustainable IT solutions (Baek & Chilimbi, 2010). This panel commenced with the premise that, even though researchers have focused on digital transformation's organizational performance aspects, they have not sufficiently examined the impact that digital transformation has on environmental sustainability.

6.1 Consolidation Frameworks

The panel first summarized digital transformation and its impact on environmental sustainability. Sedera highlighted the positive and negative effects that digital transformation initiatives have on environmental sustainability. Lokuge proposed an extension to the IT business alignment model to incorporate environmental sustainability. Then, Cooper discussed capabilities that environmentally sustainable digital transformation initiatives require. Finally, Burstein discussed how organizations could incorporate environmental sustainability in decision-making processes. In conclusion, the panel used SAM as a founding theoretical premise to discuss different aspects of environmental sustainability and digital transformation. The panel then expanded its views in four related areas (see Figure 2).

Based on the panelists' presentations and the comments they received from participants, we derived a framework for environmentally sustainable digital transformation, which we depict in Figure 3. This framework can help academics and practitioners to holistically understand the impact of environment sustainability at four levels: individual, organizational, country, and global. In the figure, "green strategy formation" (incentives column, organizational row) represents organizations' green strategic priorities.

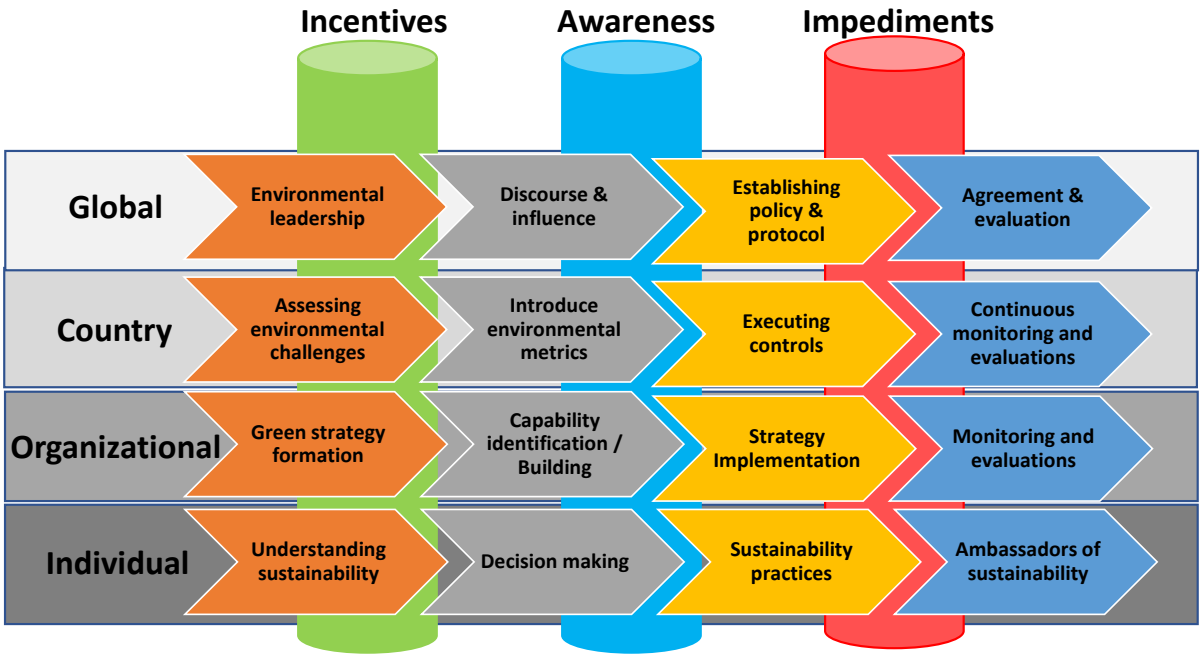

Figure 3. Consolidated Framework for Environmentally Sustainable Digital Transformation

The panel argued that a three-pillar strategy (awareness, incentives, and impediments) at four levels may help explains the implications of digital transformation initiatives. Unlike any other issue or notion, "sustainability" requires global coordination that aligns with the local, organizational, and individual levels. Awareness refers to the knowledge about the impact that digital technologies and initiatives have on the environment. Incentive refers to the motivations for conducting sustainable digital transformations. Impediments refer to obstructions for sustainable digital transformations. We propose four processes for obtaining sustainable digital transformations at the individual, organizational, country, and global levels. While we focused on only the individual and organizational levels in the panel, we extended and proposed the processes for country and global level. Empirical investigations need to examine these processes to establish them given they remain in the ideation phase.

Digital transformation, whether at the organization or country level, has potentially negative impacts on the environment. The Internet, IT infrastructure, and digital waste have the potential to pollute the earth, air, and water. However, many agree that that digital transformation represents an essential organizational, societal, and individual component. As such, the panel argued that we must find a common ground where the two concepts digital transformation and environmental sustainability can co-exist.

6.2 Future Research Areas

The panelists agreed that IS researchers need to pay additional attention to digital transformation and environmental sustainability. Prior studies have examined green innovation (Lampikoski, Westerlund, Rajala, & Möller, 2014; Schiederig, Tietze, & Herstatt, 2012), green orientation (Hong, Kwon, & Roh, 2009), green implementation frameworks (Bose & Luo, 2011), organizational support for green management (Loeser, Recker, vom Brocke, Molla, & Zarnekow, 2017), and environmental corporate social responsibility (Ambec & Lanoie, 2008). Green IS research has matured enough to form multi-disciplinary initiatives to look at the solid science behind the greening efforts and their long-term implications. We derived our framework through observations and comments from the panel session, and it opens pathways for researchers to contribute to academic knowledge and inform better industry practices.

According to Kappelman, McLean, Johnson, and Gerhart (2014), understanding business and business requirements and maintaining the IT capabilities to survive in dynamic business environments constitutes IT executives' third most frequently mentioned issue. In a highly volatile business environment with pressure emerging from the external institution to adhere to environmental regulations, organizations face immense pressure to survive. While adhering to green policies, aligning their strategic objectives requires

organizations to develop and leverage their IT capabilities. As such, researchers have the potential to investigate:

> **RQ1:** What role does IS play in facilitating environmentally sustainable digital transformation initiatives?

Answering such a question would involve exploration of several related questions, including:

> **RQ2:** How does IT facilitate organizations to balance the alignment between strategic goals and business to achieve environmental sustainability?

Brendel, Zapadka, and Kolbe (2018) analyzed previous research efforts since 2007 that produced design artifacts to address green IT. Their observations on the future opportunities for addressing outstanding research issues about the impact that digital artefacts have on the environment pertain highly to the propositions we derived. Further, Brendel, Zapadka, and Kolbe (2018) correlates to our proposition that researchers have conducted mostly atheroetical environmentally sustainable digital transformation research efforts. Hence, researchers could focus on developing a theory that would extend the green management, strategic literature, and IT capabilities body of knowledge. We propose researchers address this gap by investigating:

> **RQ3:** What relevant theories can one use to describe, explain, predict, and/or prescribe sustainable digital transformation practices?

In doing so, researchers need to determine if they can use any indigenous, IS-specific theories to describe, explain, predict, and/or prescribe environmentally sustainable digital transformation practices; to focus on design theories; and, importantly, to increase the rigor and number of quality publications in this area. IS researchers have an opportunity to engage with other relevant disciplines to inform the multidisciplinary environmental sustainability agenda in digital transformation context.

Although many IS researchers have examined big data, they have rarely investigated whether one can apply big data to environmental sustainability. As such, IS researchers have an opportunity to conduct pioneering research and providing new insights in this area. Furthermore, given that we lack existing research in the environmental sustainability stream, researchers have a clear opportunity to employ a design science approach focused on strategic decision-making using big data. Continuing Brendel et al.'s (2018) argument, we posit that we clearly need environmental sustainability design science research that focuses on strategic decision making. Using relevant sources of relevant historical (big) data should lead to practice-driven insights on the implications that digital transformation may have on individuals, organizations, countries, and the world in line with the consolidated framework that we propose. Thus, researchers could investigate:

> **RQ4:** What factors can influence practical steps in changing human decision-making behavior?

We call for future research to systematically review both the academic and practitioner literature to identify case studies that describe the ways in which digital transformation projects have covered environmental sustainability issues. They could create sound methodological guidelines and practitioner-focused policies and implement them in technical artefacts as part of research and development efforts for sustainable digital transformation. They could also propose suitable IS curricular to include in teaching environmentally conscious, socially responsible IT professionals for the future.

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About the Authors

Sachithra Lokuge is a Lecturer in Information Systems at the College of Business and Law at the RMIT University, Australia. Her research mainly focuses on digital technologies, innovation, digital entrepreneurship and social media use. Her work has been published in journals such as the *Information & Management, Information Technology and People*, *Communications of the Association for Information* Systems, *Journal of Information Technology Theory and Application* (*JITTA*), and in the proceedings of conferences such as the International Conference on Information Systems and Academy of Management.

Darshana Sedera is a Professor of Information Systems and the Director of the Digital Enterprise Lab at the Southern Cross University in Australia. He is currently the Deputy Dean of the School of Business and Tourism. He has published over 200 publications in major refereed journals and conferences. His publications have appeared in *Journal of the Association for Information Systems*, *Journal of the Strategic Information Systems*, *Information & Management*, *Information Technology & People*, and *Communications of the Association for Information Systems*.

Vanessa Cooper is a Professor in Information Systems at RMIT University, Melbourne, Australia and leader of the Digital Work and Society research program in the Centre for People, Organization and Work. Her research in information systems centers on the application of knowledge management and organizational learning theory in contexts such as environmental sustainability, emergency management and the future of work. Her research has been published in leading academic journals and won multiple awards, including best paper awards at international conferences and from the Australian Computer Society.

Frada Burstein is a Professor of Information Systems at the Department of Human-Centered Computing, Faculty of Information Technology, Monash University. She was the Deputy Director of the Centre for Organizational and Social Informatics and led the Community Health and Wellbeing Informatics theme for the research flagship “IT for Resilient Communities”. Her professional academic career spans more than twenty years and includes extensive research in the areas of decision support systems, knowledge management, and more recently in digital transformation of healthcare. In 2013, she was named the ICT Educator of the Year for her contribution to information and communications technology (ICT) education. Prof Burstein is a Fellow of Australian Computer Society and a Distinguished Member of the Association for Information Systems. Her research appears in such journals as *Decision Support Systems*, *Journal of the American Society for Information Science and Technology*, *Journal of IT*, *Journal of Knowledge Management*, *Knowledge Management Research and Practice*, and others.