12-2-2023

# Designing for Climate Risk Response Readiness System: A Design Science Research Study

Xiangyu Wang
*School of Information Systems and Technology Management, University of New South Wales (UNSW), Australia*, xy.wang@unsw.edu.au

M.S. Sandeep
*School of Information Systems and Technology Management, University of New South Wales (UNSW), Australia*, ms.sandeep@unsw.edu.au

Yenni Tim
*School of Information Systems and Technology Management, University of New South Wales (UNSW), Australia*, yenni.tim@unsw.edu.au

Shan L. Pan
*School of Information Systems and Technology Management, University of New South Wales (UNSW), Australia*, shan.pan@unsw.edu.au

Fei Ji
*NSW Department of Planning and Environment, Sydney. Australia*, fei.ji@environment.nsw.gov.au

# Designing for Climate Risk Response Readiness System: A Design Science Research Study

## Research-in-progress

**Xiangyu Wang**
School of Information Systems and Technology Management
University of New South Wales
Sydney, New South Wales, Australia
Email: xy.wang@unsw.edu.au

**M.S. Sandeep**
School of Information Systems and Technology Management
University of New South Wales
Sydney, New South Wales, Australia
Email: ms.sandeep@unsw.edu.au

**Yenni Tim**
School of Information Systems and Technology Management
University of New South Wales
Sydney, New South Wales, Australia
Email: yenni.tim@unsw.edu.au

**Shan L. Pan**
School of Information Systems and Technology Management
University of New South Wales
Sydney, New South Wales, Australia
Email: shan.pan@unsw.edu.au

**Fei Ji**
NSW Department of Planning and Environment
Sydney, New South Wales, Australia
Email: fei.ji@environment.nsw.gov.au

## Abstract

This research-in-progress paper presents a design science research (DSR) project that develops design principles for an intelligence system targeted to enhance organizational readiness of climate risk response. We identified a set of theory-inspired design principles through a single cycle of prototyping, demonstration, and evaluation. Through our DSR project, we develop design knowledge that can support organisations to design intelligence IS that support risk mitigation in the face of climate change challenges. Our preliminary findings highlight the significance of incorporating IS into organizations' climate change adaptation and mitigation strategies, ultimately paving the way for more effective and informed decision-making in a rapidly changing environment.

**Keywords:** Climate Risk and Response, Design Science, Readiness, Climate Risk Analytics, Intelligence System

# 1. Introduction

Sustainability is receiving increasing public attention; most governments are giving high priority to addressing sustainability on their legislative agendas (Haanaes et al. 2011). According to a new Gartner, Inc. survey, 87% of business leaders expect to increase their organization's investment in sustainability over the next two years (Gartner 2022). This response reflects the recognition of the alarming challenges humanity faces, such as extreme weather events, resource scarcity, and environmental degradation, which have far-reaching consequences for society, the economy, and environment (IPCC 2021). These challenges create a complex interplay of risks that can significantly impact economies and ecological systems.

In this intricate environment, stakeholders, including investors, consumers, and the broader society, have heightened expectations for organizations to proactively address and mitigate climate risks, considering it a crucial step towards promoting sustainable development and safeguarding societal well-being (KPMG 2020). The readiness of an organization to effectively respond to these climate risks, in other words, their "climate risk response readiness" (CRR-R), may have a profound impact on their perceived accountability, trustworthiness, and consequently, their legitimacy in dealing with climate-related challenges. A concrete example highlighting this growing demand for transparency and accountability is the legal action taken by shareholders of the Commonwealth Bank by suing over its failure to adequately disclose the risks posed by climate change to businesses in 2017 (Darby 2017; Slezak 2017). This action underscores the urgent need for organizations to develop climate risk response capability, which we define as an organization's capability to decisively react to climate risks as they manifest, developed through a process of self and environmental assessment and preparation for potential risks (Hahn et al. 2014). We suggest that organizations with CRR-R capability have an advantageous position not only in mitigating climate-related risks, but also in enhancing their legitimacy and gaining acceptance from their stakeholders.

Enhancing the CRR-R of organizations is not only important for protecting stakeholder interests and ensuring compliance with laws and regulations, but also plays a vital role in contributing to the long-term well-being of society. Intelligence Systems (InS) solutions, such as those equipped with analytic functions for generating insights and improving managerial decision making (Li et al. 2013), could support organizations in strengthening their CRR-R through systematic self and environmental assessments. However, there is currently limited design knowledge that could guide the development of such systems. To address this limitation, we initiated a Design Science Research (DSR) project to develop and evaluate an intelligence system, formulating new design knowledge to address this research question: *What are the design principles for an intelligence system that* ***enhances*** *the CRR-R of organisations?*

# 2. Conceptual Background

## 2.1. Intelligence Systems for Climate Risk Response Readiness

We use the term CRR-R to refer to the preparedness and capacity of organizations to effectively address the challenges posed by climate change. Our focus is on the design, deployment, and use of intelligence system solutions to **promote** such readiness. Despite climate change being one of the most significant societal challenges of our time (Gholami et al. 2016), it remains an underexplored research agenda in IS (Pan et al. 2022). Among the handful of existing research, the majority focused on the propensity for organizations to adopt and embrace a technology (Parasuraman and Colby 2015). However, research situated in the context of climate risk response has been limited. This gap is increasingly problematic today as organizations face mounting pressure to improve their climate response strategies, yet do not have clear guidance on how to proceed.

In this research, we leveraged principles of readiness from supply chain risk context and management literature to develop the concept of CRR-R (Bode and Macdonald 2017). The concept of readiness encompasses two key components: 1) self and environmental assessment for potential risks, and 2) preparation for potential risks. Through the comprehensive engagement with both aspects of readiness – self and environmental assessments – organizations can enhance their ability to manage the complex challenges of climate change, minimizing potential negative impacts on their operations, stakeholders, and the broader environment. A robust CRR-R demonstrates an organization's deep understanding of the risks posed by climate change and its preparedness to implement necessary mitigation strategies. This readiness not only aids in navigating climatic challenges but also contributes to strengthening the organization's legitimacy in the eyes of its stakeholders.

## 2.2. Legitimacy Theory

Failing to address climate risks adequately can threaten an organization's legitimacy. Considering the nature of this issue – related to societal expectations and legitimacy concerns surrounding climate change and risk response – we turn to legitimacy theory (Suchman 1995). Rooted in sociology and organizational theory, legitimacy theory offers a valuable lens through which we can evaluate the impact of CRR-R on organisational credibility and capacity to take action on climate risks.

Legitimacy is a perception or assumption that the actions of an entity are desirable, proper, or appropriate within a socially constructed system of norms, values, beliefs, and definitions (Suchman 1995). This definition underscores that legitimacy is a socially constructed concept that relies on how an organization's actions are perceived and interpreted by both internal and external stakeholders (e.g., employees, consumers, and policy makers).

A key point about legitimacy is that it requires stakeholders' continuous attention since the expectations from stakeholders can change over time. In accordance with legitimacy theory, stakeholders deliberate on activities that align with the firm, and it is expected that firms conduct their activities within the defined boundaries of these aligned standards (Deephouse and Suchman 2008; Suchman 1995). Therefore, organizations must continuously reflect upon their actions, understand the prevailing norms within their industry, and monitor how these norms have evolved over time to maintain their legitimacy. In the context of climate risk response, upholding legitimacy presents a significant challenge for organizations. This process necessitates that organizations meticulously monitor a wide array of risks while concurrently adapting to dynamic stakeholder expectations. It also demands a culture of transparency, proactivity, and the constant adjustment of risk management strategies. We address these organizational needs associated with CRR-R, as illuminated by a legitimacy perspective, through a DSR project.

# 3. Design Science Research Approach

Our goal is to develop a set of design principles for an intelligence system that organizations can use to enhance their readiness in responding to climate risk. We adopted the staged DSR framework proposed by Peffers et al. (2007). Our research process begins with the problem identification and objectives, followed by iterative refinement and a sequence of incremental optimizations of the design principles to align with the final design objectives (Hevner et al. 2004). This process finally culminates in the demonstration and evaluation of the principles. Figure 1 visualizes our research process.

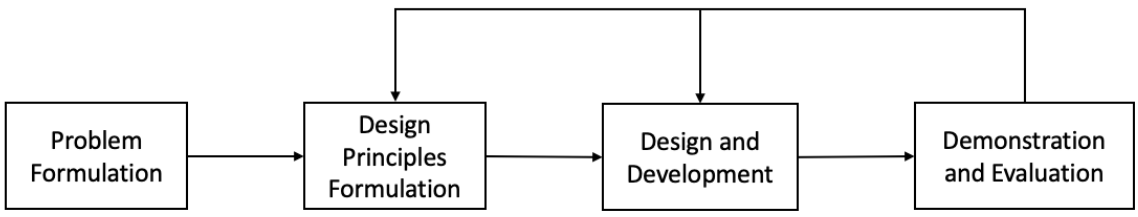


*Figure 1: The Design Science Research Process.*

The data source of our intelligence system comprises Task Force on Climate-related Financial Disclosures (TCFD) reports published by various organizations, providing insights in the financial risks and opportunities associated with climate change. The TCFD focuses on reporting the impact an organization has on the global climate, aiming to make climate-related disclosures more consistent and comparable. The TCFD offers a consistent disclosure recommendation-based reporting framework for organizations, enhancing transparency about their climate-related risk exposures. The adoption and analysis of TCFD reports not only provide insights into the environmental impact of organizations but also contribute to assessing their climate risk and response readiness, as the framework encourages companies to disclose information related to governance, strategy, risk management, and metrics and targets in the context of climate-related risks and opportunities. The analysis of TCFD data allows us to make informed assessments and recommendations regarding organizations' climate-related risks and opportunities. Leveraging these reports, we developed a functional proof-of-concept for a CRR-R intelligence system, conducted evaluations, and aimed to subsequently iteratively formulate and refine our design principles.

## 3.1. Problem Identification and Objectives

Climate change poses significant challenges to organizations since stakeholder expectations are demanding greater transparency and accountability regarding climate risks. To retain the trust of stakeholders, organizations need to demonstrate a legitimate response to climate risks. As these risks continue to evolve, organizations are increasingly acknowledging the crucial role of an intelligence system in actively identifying, assessing, and mitigating these risks, thereby ensuring long-term sustainability. To address these challenges, our study has embarked on the design of a multifaceted intelligence system. Our system aims to empower organizations in effectively responding to climate risks. It ensures transparent communication of actions, facilitates benchmarking against industry competitors, identifies actionable opportunities, and robustly supports decision-making processes. Moreover, it is designed with versatility in mind, allowing adaptability to the unique needs of different sectors since the level of details and the presence of standards may vary across organizations.

## 3.2. First Round of Design, Development, Demonstration and Evaluation

The initial design principles were informed by the three main tenets of legitimacy theory: a) the need for organizations to deliberate on activities within the firm, b) understand the prevailing norms and established standards in their industry, and c) continuously assess and monitor how the norms and standards are evolving.

Transparency and clarity are key elements when managing and communicating climate risks within an organization. Given the complexity of climate risk-related data, we identified the need for a system that could consolidate relevant data sources and present synthesised insights in a visually comprehensive manner. Correspondingly:

**DP 1**: The system should provide a comprehensive visualisation of the climate risks that the organizations are managing within the TCFD framework.

Furthermore, to enable organizations to accurately assess and communicate their climate-related risks, as well as to develop transparent and accountable climate risk response practices, the system should offer detailed insights into the disclosure coverage. Disclosure coverage reflects company's critical aspects of climate-related risks and opportunities aligned with the TCFD framework, enables organizations to identify and prepare for climate risks and strengthens its overall climate risk response readiness. Correspondingly:

**DP 2**: The system should provide knowledge on a thorough and standardized examination of disclosures in the TCFD framework.

Figure 2 shows screenshots of our intelligence system in the first design cycle. Our system starts with a company level analysis (Figure 2), intending to provide an entry point for understanding the current state of climate risk and response based on the TCFD framework (DP 1). To allow users to thoroughly examine disclosure coverage in each component, the system provides the comparison of performance across components, highlights the strengths and weaknesses, and relative performance assessment in each subcategory (DP 2). The above information is reflected in the bar chart and radar chart (Figure 2), which show descriptive information based on TCFD disclosures.

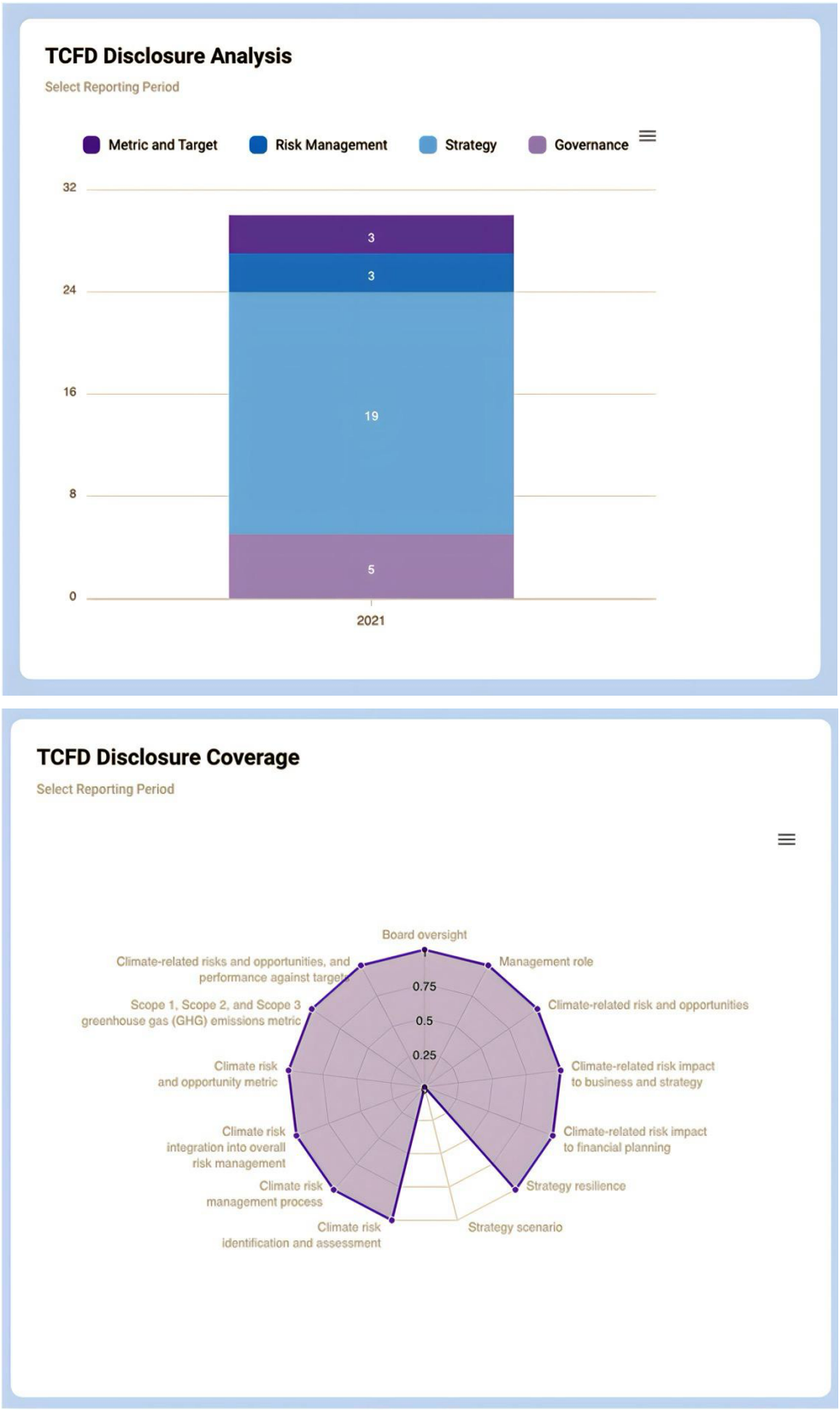


*Figure 2: An overview of TCFD disclosure analysis and coverage extracted from the intelligence system.*

In addition, to better align organizations with societal expectations regarding climate responsibility, and to ensure informed responses to climate risks, the intelligence system needs to provide functionalities for customized benchmarking analysis and dynamic self-assessment over time. Specifically, the system

should empower organizations to compare and evaluate their risk mitigation strategies against industry benchmarks. Such benchmarking helps organizations to assess the effectiveness of their risk mitigation strategies over time, enabling data-driven decision. Correspondingly:

**DP 3**: The system should provide benchmarking capability for risk mitigation strategy analysis.

To enhance benchmarking analysis (DP3), we built a "Highlights and Opportunities" feature in the intelligence system, empowering users to delve into more detailed information pertaining to each pillar of TCFD disclosures (Figure 3).

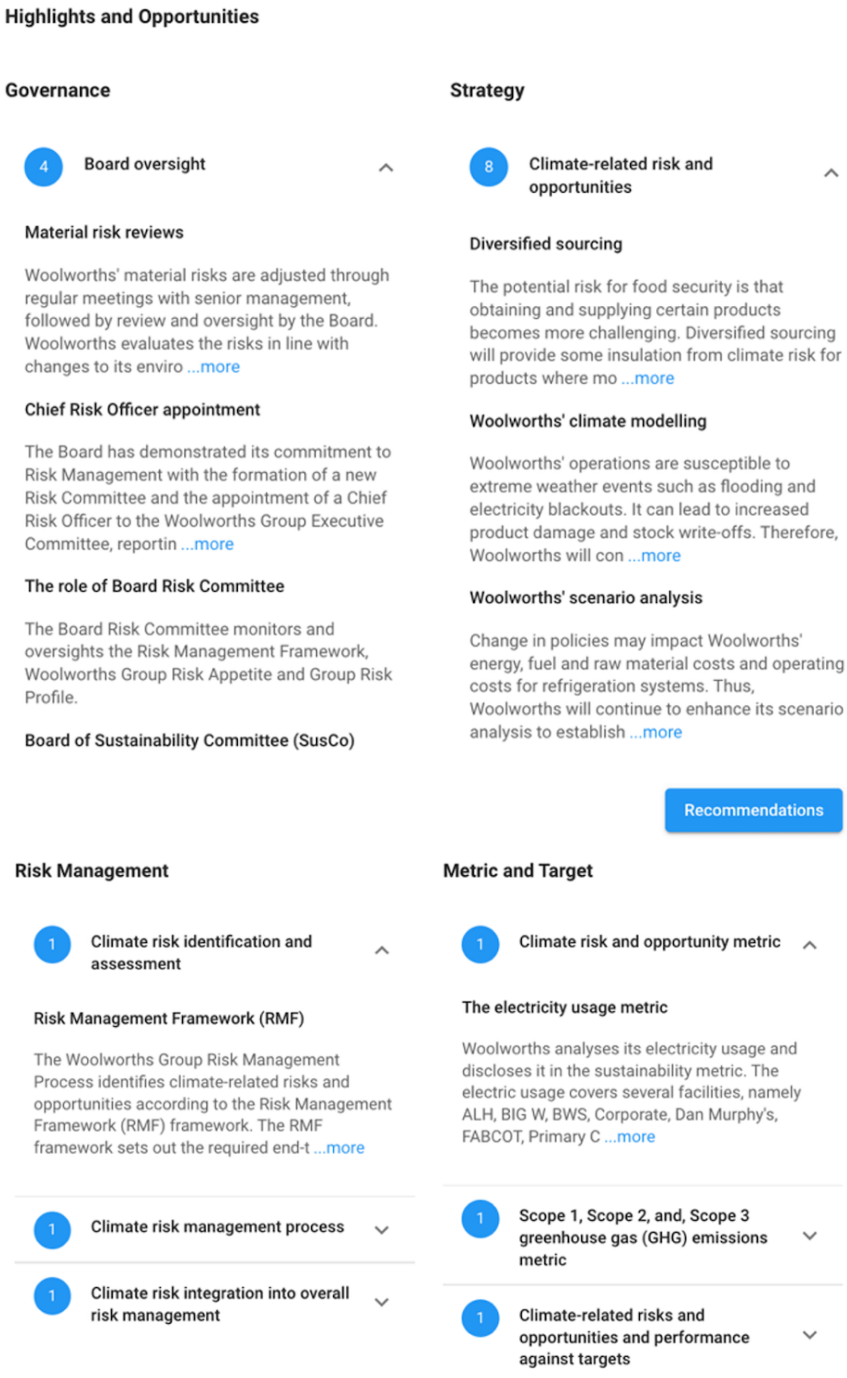


*Figure 3: Four pillars of TCFD disclosures extracted from the intelligence system.*

We also identified the importance of integrating a temporal dimension into the system. We have identified that providing insights into the progression, performance, and adaptability of risk mitigation strategies over time imparts vital insights for organizations navigating changing circumstances. Equipped with this capability for temporal analysis, organizations are granted a deeper understanding of the evolution of their strategies' effectiveness and the dynamic nature of risks. Consequently, this facilitates more informed, data-driven decision-making and strategy adaptation, promoting organisational resilience and responsiveness. From this insight, we established:

**DP 4**: The system should facilitate temporal analysis of risk mitigation strategies.

In our first round of design cycle, we evaluated the prototype with 60 users over a span of 10 weeks. Throughout this evaluation period, we identified and promptly addressed minor technical issues as they emerged. We also received valuable user feedback indicating the need for more customizable visualizations, which would further facilitate informed decision-making processes. We will incorporate this feedback and further refine our design principles in future rounds of the DSR process.

## 4. Discussion and Conclusion

In this research-in-progress paper, we investigate how information systems can be designed to support CRR-R through a legitimacy lens. As part of our ongoing DSR project, we have created a set of design principles derived from a preliminary round of prototype building and evaluation. The novelty of this study primarily stems from our use of the legitimacy lens to enhance understanding and guide the design of IS solutions for CRR-R. Our preliminary findings provide insights that will inform the design of intelligence IS aiming at equipping organizations with the capabilities to effectively respond to complex climate risks while maintaining their organizational legitimacy and resilience amidst evolving sustainability challenges.

## References

Bode, C., and Macdonald, J. R. 2017. "Stages of Supply Chain Disruption Response: Direct, Constraining, and Mediating Factors for Impact Mitigation," *Decision Sciences* (48:5), Wiley Online Library, pp. 836–874.

Darby, M. 2017. "Australian Bank Sued over Failure to Disclose Climate Risks," *Climate Home News*.

Deephouse, D. L., and Suchman, M. 2008. "Legitimacy in Organizational Institutionalism," *The Sage Handbook of Organizational Institutionalism* (49), p. 77.

Gartner. 2022. "Gartner Survey Finds 87% of Business Leaders Expect to Increase Sustainability Investment Over the Next Two Years."

Gholami, R., Watson, R. T., Hasan, H., Molla, A., and Bjorn-Andersen, N. 2016. "Information Systems Solutions for Environmental Sustainability: How Can We Do More?," *Journal of the Association for Information Systems* (17:8), p. 2.

Haanaes, K., Arthur, D., Balagopal, B., Kong, M. T., Reeves, M., Velken, I., Hopkins, M. S., and Kruschwitz, N. 2011. "SUSTAINABILITY: THE 'EMBRACERS' SEIZE ADVANTAGE," *MITSloan Management Review*. (https://sloanreview.mit.edu/projects/sustainability-the-embracers-seize-advantage/).

Hahn, T., Preuss, L., Pinkse, J., and Figge, F. 2014. "Cognitive Frames in Corporate Sustainability: Managerial Sensemaking with Paradoxical and Business Case Frames," *Academy of Management Review* (39:4), Academy of Management Briarcliff Manor, NY, pp. 463–487.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75–105.

IPCC. 2021. "Climate Change 2021: The Physical Science Basis."

KPMG. 2020. "The Time Has Come: The KPMG Survey of Sustainability Reporting 2020."

Li, X., Hsieh, J. J. P.-A., and Rai, A. 2013. "Motivational Differences across Post-Acceptance Information System Usage Behaviors: An Investigation in the Business Intelligence Systems Context," *Information Systems Research* (24:3), INFORMS, pp. 659–682.

Pan, S. L., Carter, L., Tim, Y., and Sandeep, M. S. 2022. "Digital Sustainability, Climate Change, and Information Systems Solutions: Opportunities for Future Research," *International Journal of*

*Information Management* (63), Elsevier, p. 102444.

Parasuraman, A., and Colby, C. L. 2015. "An Updated and Streamlined Technology Readiness Index: TRI 2.0," *Journal of Service Research* (18:1), Sage Publications Sage CA: Los Angeles, CA, pp. 59–74.

Peffers, K., Tuunanen, T., Rothenberger, M. A., and Chatterjee, S. 2007. "A Design Science Research Methodology for Information Systems Research," *Journal of Management Information Systems* (24:3), Taylor & Francis, pp. 45–77.

Slezak, M. 2017. "Commonwealth Bank Shareholders Sue over 'inadequate' Disclosure of Climate Change Risks," *The Guardian*.

Suchman, M. C. 1995. "Managing Legitimacy: Strategic and Institutional Approaches," *Academy of Management Review* (20:3), Academy of Management Briarcliff Manor, NY 10510, pp. 571–610.