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Moderating Role of Business Analytics Capability in Implementation of Circular Economy: A Conceptual Path Model

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ABSTRACT

Today, amidst the widespread digital transformation of organizations, environmental concerns loom large, propelling sustainability and the circular economy to the forefront of corporate priorities. In this context, information systems, notably business analytics, emerge as a catalyst to a circular economy. There are significant challenges a company face with identifying the key organizational resources to target and how best to leverage them towards establishing a comprehensive business analytics capability for the circular economy. To tackle these challenges, this study synthesizes recent literature on smart circular economy practices and business analytics capabilities. The proposed research model undergoes empirical testing through past studies and literature. The study can be further taken forward for organisational based responses and using structural equational modelling for the policy making.

Interestingly, the impact of business analytics capability on firm performance is not direct but is entirely mediated through resource orchestration capability and circular economy implementation. These results empirically validate the research model and chart a course for future information systems research endeavors aimed at operationalizing circular strategies. Importantly, this study furnishes the initial empirical evidence of the pivotal role played by business analytics capability in the circular economy and its profound implications for firm's performance.

Keywords Circular economy, data analytics, sustainability

Introduction

The concept of the circular economy (CE) is the buzzword across industries, in policymaking circles, and within academia. It represents a total change aimed at enhancing organisation's performance without depleting resources beyond the Earth's sustainable capacity. The circular economy embodies a production and consumption model characterized by practices such as sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products to prolong their lifecycle. By minimizing waste, this approach aims to extend the longevity of products, thereby maximizing resource efficiency. The circular economy holds significant promise as a driver of sustainability and directly aligns with several United Nations' Sustainable Development Goals. The benefits of adopting a circular economy approach are wide-ranging and significant. Firstly, it promotes resource efficiency by minimizing waste generation and optimizing the use of materials through practices such as reuse, refurbishment, and recycling. This not only conserves valuable resources but also reduces the environmental impact associated with extraction and disposal.

Financially, embracing circular economy principles can lead to cost savings for businesses. By streamlining production processes, reducing reliance on expensive raw materials, and minimizing waste disposal costs, companies can improve their bottom line and enhance profitability. Moreover, the circular economy fosters innovation and entrepreneurship. It encourages the development of new technologies, business models, and products designed for durability, reparability, and recyclability. This creates opportunities for companies to differentiate themselves in the market and tap into new revenue streams. From an environmental perspective, the circular economy helps mitigate ecological degradation and combat climate change. By reducing resource extraction, energy consumption, and greenhouse gas emissions associated with traditional linear production and consumption models, it contributes to environmental preservation and sustainability.

Socially, the circular economy has the potential to create jobs and foster inclusive growth. Industries such as recycling, remanufacturing, and renewable energy offer employment opportunities while also promoting local economic development and resilience. Furthermore, embracing circular economy principles can enhance brand reputation and consumer trust. Companies that demonstrate a commitment to sustainability and

environmental responsibility are often viewed more favorably by customers and stakeholders, leading to increased loyalty and market share. Overall, the transition to a circular economy offers a holistic approach to addressing pressing societal and environmental challenges while also unlocking economic opportunities and promoting long-term prosperity.

However, industry adoption of circular economy and sustainable strategies has been relatively modest so far. One of the major challenges is technological barriers because implementing circular economy practices often requires innovative technologies for material recovery, recycling, and waste management. Developing and deploying these technologies at scale can be costly and complex.

Literature review:

Business analytics capability:

Business Analytics encompasses a range of technologies, methodologies, and applications designed to analyze business data, facilitating informed and data-driven decision-making processes. In this study, the term "big data analytics" is used to refer to the innovative methods and applications tailored for processing exceptionally large and intricate datasets that surpass the capabilities of conventional analytical approaches. It is considered synonymous with "business analytics" (BA), reflecting a unified perspective in the context of this research. The notion of a "business analytics capability" has surfaced to denote a company's adeptness in harnessing its data, technology infrastructure, and human talent to efficiently derive actionable insights through data-driven approaches.

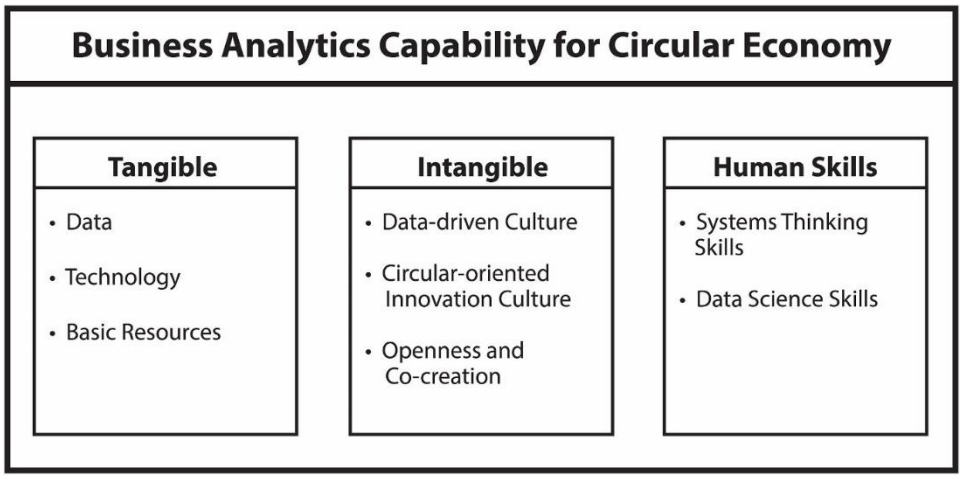

Figure 1. Business Analytics Capability

Circular economy implementation:

Foundational works by organizations like the Ellen MacArthur Foundation have laid the groundwork for conceptualizing and defining the circular economy, emphasizing the importance of regenerative systems and closed-loop processes. Scholars and practitioners have delved into various aspects of circular economy implementation, shedding light on both the opportunities and challenges inherent in transitioning to circular models of production and consumption. One key area of focus has been the development and exploration of circular business models, including product-as-a-service, sharing platforms, and closed-loop manufacturing. Studies by researchers such as Geissdoerfer et al. (2017) and Ghisellini et al. (2016) have provided valuable insights into the potential benefits and feasibility of these models across different industries. Alongside the promise of circular economy lies a host of barriers and challenges that must be addressed. Regulatory hurdles, technological limitations, and market dynamics can hinder the widespread adoption of circular practices. Scholars like Schröder et al. (2019) have highlighted the importance of addressing these barriers through targeted policy interventions, innovation strategies, and cross-sector collaboration.

The successful implementation of circular economy principles relies on the development of robust supply chains, innovative design practices, and metrics for measuring performance. Tukker et al. (2015) and Velenturf et al. (2016) have contributed to this area of research by exploring the role of supply chain management and the development of circular economy indicators. The transition to a circular economy is not confined to specific sectors but has implications for industries ranging from manufacturing to construction, electronics, and textiles. Case studies and empirical analyses have provided valuable insights into sector-specific challenges and opportunities, highlighting the need for tailored strategies and interventions.

Overall, the literature on circular economy implementation underscores the transformative potential of circular models of production and consumption while also highlighting the need for interdisciplinary collaboration, policy support, and innovation to overcome barriers and realize the full promise of the circular economy. Scholars have further added the role of circularity in achieving sustainable development goals and fostering economic resilience. Studies by authors such as Kirchherr et al. (2017) and Charter and Tischner (2001) have emphasized the importance of aligning circular economy strategies with broader sustainability objectives, including poverty alleviation, social equity, and environmental conservation.

However, challenges remain in scaling up circular economy initiatives and overcoming entrenched linear business models and consumption patterns. Scholars and practitioners continue to explore strategies for mainstreaming circularity, including the role of education, consumer awareness, and collaborative networks in driving systemic change. Overall, the literature on circular economy implementation reflects a growing recognition of the need for transformative approaches to address interconnected social, environmental, and economic challenges. By harnessing the principles of circularity, stakeholders across sectors and scales can work towards a more resilient, equitable, and sustainable future.

Thus, the summary for the circular economy implementation and its challenge can be tabulated as:

1. Regulatory and Policy Frameworks: Existing regulations and policies may not adequately support or incentivize circular economy practices. Reforms are needed to align regulatory frameworks with circularity goals and provide incentives for businesses to adopt circular practices.

2. Technological Limitations: Advanced technologies are often required to facilitate the efficient recovery, recycling, and reuse of materials. However, the development and deployment of these technologies can be costly and complex, posing a barrier to circular economy implementation.

3. Market Dynamics: Circular economy models may face resistance or scepticism from traditional linear market structures. Convincing stakeholders of the economic viability and long-term benefits of circularity can be challenging, especially in industries with entrenched linear business models.

4. Organizational Change: Transitioning to a circular economy requires organizational change and innovation. Businesses may need to reevaluate their processes, products, and business models to align with circular principles, which can be disruptive and resource-intensive.

5. Education and Awareness: Many stakeholders, including businesses, policymakers, and consumers, may lack awareness or understanding of the concept and benefits of the circular economy. Education and awareness-raising efforts are needed to promote understanding and foster support for circularity initiatives.

Conceptual Model:

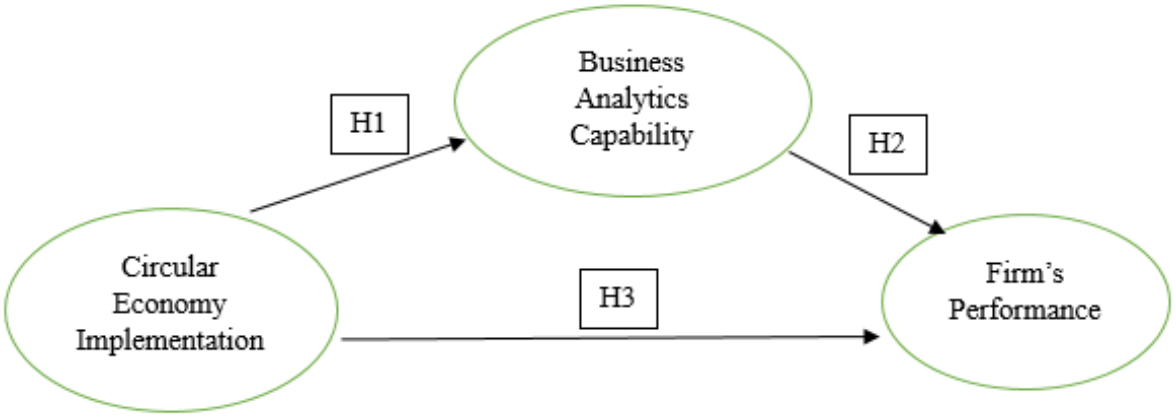

Fig 2: Conceptual Model

The study suggests the three latent variables viz., Circular Economy Implementation (CEI), Business Analytics Capability (BAC), and Firm's Performance (FP). These are further defined by observed variables as questionnaire items of measurement scale. This scale is developed based on past studies and literature reviews based on CEI, BAC and an organisation's performance. A quick suggestive sample is attached in Appendix 1.
The alternate hypotheses will be:

H1: CEI have a positive effect on Firm's Performance.
H2: BAC has a positive effect on Firm's Performance.
H3: CEI has a positive effect on Firm's Performance, moderated by BAC.

Alternate Hypotheses	Statement
H1	CEI have a positive effect on Firm's Performance.
H2	BAC has a positive effect on Firm's Performance.
H3	CEI has a positive effect on Firm's Performance, moderated by BAC.

Table 1: Alternate Hypotheses

Business Analytics Capability (BAC) is defined by three types of resources tangible, intangible and human resources. These factors are defined as observed variables and questions are framed based on data, technology, basic resources, data-driven culture, innovation culture, system thinking data science skills etc. The observed variable circular economy implementation (CEI) is further developed with factors like regulatory framework, policy support, technology capabilities, market dynamics, organisation change, education and awareness etc.

Industry Implications:

The research can demonstrate that role of Business Analytics (BA) on firms' implementation of circular strategies and how it can enhance organizational performance across various dimensions, including competitiveness, corporate reputation, financial results, and environmental efforts. These findings can support a compelling business rationale for companies to adopt Circular Economy (CE) and capitalize on BA investments. For forward-thinking managers and early circular economy adopters seeking justification for corporate strategy changes, this research offers valuable evidence supporting the transition to a more sustainable mode of business operation.

It can also help companies identify which organizational resources and capabilities are critical for leveraging BA for circular economy initiatives. As firms adapt their business operations to meet evolving customer demands and sustainability requirements, strategic investments become paramount for long-term competitiveness and survival. By understanding the key resources and capabilities needed to effectively harness BA for CE, companies can allocate resources more efficiently and enhance their ability to capitalize on circular economy opportunities.

Appendix 1

1.How would you rate your organization's readiness to embrace data-driven decision-making and innovation culture across the following factors?

Scale 1 indicating "Least Agree" and 5 indicating "Highly Agree."

Latent Variable (BAC)	1	2	3	4	5
Q1. Data Availability and Accessibility					
Q2. Technological Infrastructure and Tools					
Q3. Availability of Basic Resources (e.g., budget, manpower)					
Q4. Cultivation of a Data-Driven Culture					
Q5. Fostering an Innovation Culture					
Q6. Embracing Systems Thinking Approach					
Q7. Proficiency in Data Science Skills					

2. "How would you rate the following factors in influencing the challenge of implementing circular economy practices within your organization or industry?

Latent Variable (CEI)	1	2	3	4	5
Q1. Lack of supportive regulations					
Q2. Insufficient government incentives					
Q3. Limited access to advanced recycling and remanufacturing technologies					
Q4. Firm's inadequacy for business analytics					
Q5. Lack of consumer demand for circular products/services					
Q6. Resistance to change within the organization					

References:

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy–A new sustainability paradigm?. *Journal of cleaner production*, *143*, 757-768.

Charter, M., & Tischner, U. (Eds.). (2017). *Sustainable solutions: developing products and services for the future*. Routledge.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological economics*, *150*, 264-272.

Velenturf, A. P., & Jensen, P. D. (2016). Promoting industrial symbiosis: Using the concept of proximity to explore social network development. *Journal of Industrial Ecology*, *20*(4), 700-709.

Tukker, A. (2015). Product services for a resource-efficient and circular economy–a review. *Journal of cleaner production*, *97*, 76-91.

Corvellec, H., Stowell, A. F., & Johansson, N. (2022). Critiques of the circular economy. *Journal of industrial ecology*, *26*(2), 421-432.

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: the concept and its limitations. *Ecological economics*, *143*, 37-46.

Prieto-Sandoval, V., Jaca, C., & Ormazabal, M. (2018). Towards a consensus on the circular economy. *Journal of cleaner production*, *179*, 605-615.

Awan, U., Shamim, S., Khan, Z., Zia, N. U., Shariq, S. M., & Khan, M. N. (2021). Big data analytics capability and decision-making: The role of data-driven insight on circular economy performance. *Technological Forecasting and Social Change*, *168*, 120766.

Pagoropoulos, A., Pigosso, D. C., & McAloone, T. C. (2017). The emergent role of digital technologies in the Circular Economy: A review. *Procedia cirp*, *64*, 19-24.

Liu, Q., Trevisan, A. H., Yang, M., & Mascarenhas, J. (2022). A framework of digital technologies for the circular economy: Digital functions and mechanisms. *Business Strategy and the Environment*, *31*(5), 2171-2192.

Luoma, P., Toppinen, A., & Penttinen, E. (2021). The role and value of data in realising circular business models–a systematic literature review. *Journal of business models*, *9*(2), 44-71.

Tseng, M. L., Tan, R. R., Chiu, A. S., Chien, C. F., & Kuo, T. C. (2018). Circular economy meets industry 4.0: Can big data drive industrial symbiosis?. *Resources, conservation and recycling*, *131*, 146-147.

Serna-Guerrero, R., Ikonen, S., Kallela, O., & Hakanen, E. (2022). Overcoming data gaps for an efficient circular economy: A case study on the battery materials ecosystem. *Journal of Cleaner Production*, *374*, 133984.

Le, T. T. (2023). Linking big data, sustainable supply chain management and corporate performance: The moderating role of circular economy thinking. *The International Journal of Logistics Management*, *34*(3), 744-771.

Kristoffersen, E., Mikalef, P., Blomsma, F., & Li, J. (2021). Towards a business analytics capability for the circular economy. *Technological Forecasting and Social Change*, *171*, 120957.

Kristoffersen, E., Blomsma, F., Mikalef, P., & Li, J. (2020). The smart circular economy: A digital-enabled circular strategies framework for manufacturing companies. *Journal of business research*, *120*, 241-261.

Kazancoglu, Y., Ozbiltekin Pala, M., Sezer, M. D., Luthra, S., & Kumar, A. (2021). Drivers of implementing Big Data Analytics in food supply chains for transition to a circular economy and sustainable operations management. *Journal of Enterprise Information Management*.

Bianchini, A., Rossi, J., & Pellegrini, M. (2019). Overcoming the main barriers of circular economy implementation through a new visualization tool for circular business models. *Sustainability*, *11*(23), 6614.

Pagoropoulos, A., Pigosso, D. C., & McAloone, T. C. (2017). The emergent role of digital technologies in the Circular Economy: A review. *Procedia cirp*, *64*, 19-24.

Bressanelli, G., Adrodegari, F., Perona, M., & Saccani, N. (2018). Exploring how usage-focused business models enable circular economy through digital technologies. *Sustainability*, *10*(3), 639.

Ranta, V., Aarikka-Stenroos, L., & Väisänen, J. M. (2021). Digital technologies catalyzing business model innovation for circular economy—Multiple case study. *Resources, conservation and recycling*, *164*, 105155.