A Case Study-based Model for Sustainable Business Management through Blockchain Technology in Small and Medium-sized Enterprises

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Abstract

The study examined the use of Blockchain Technology (BCT) in the Circular Economy (CE) to enhance the efficiency of Small and Medium-sized Enterprises (SMEs). It introduces a Sustainable Circular Business (SCB) concept that employs BCT to improve the efficiency of SMEs. A closed-ended quantitative survey was administered to collect cross-sectional information from 280 SMEs. A total of 450 questionnaires were distributed, and 290 responses were collected. The CE approach in Circular Supply Chain Management (CSCM) offers ecological and financial advantages to enterprises. The emergence of the Industry 4.0 era has intensified the emphasis on technology in all sectors. The advent of BCT, a relatively novel phenomenon, holds substantial promise for improving the operations of SMEs. The results demonstrate that BCT prefers the CE because of its attributes: exposure, responsibility, relationship administration, and intelligent contracting. It has been ascertained that implementing ecologically sustainable practices positively correlates with ecological and economic efficiency. The firm's environmental responsibility positively correlated with its financial success. It was determined that both environmental and financial capacities contributed to the higher efficiency of SMEs.

Keywords: Sustainable Business Management; Small and Medium-sized Enterprises; Blockchain; Sustainability.

I. INTRODUCTION

Various external factors are compelling corporations to adopt new business approaches and advocate for Sustainable Business Models (SBMs) (Karuppiah et al., 2023). This encompasses a growing customer awareness of climate change issues and escalating inequality among various demographic groups. Corporate practices are increasingly transforming by integrating profit generation with attaining social and ecological advantages for all stakeholders. Pursuing SBMs entails integrating triple-bottom-line methodologies that account for the needs of many users.

Various national and transnational entities advocate for these initiatives. The United Nations, via the Sustainable Development Goals (SDGs), advocates for modifications in corporate cash flow generation from core business operations by implementing sustainable technologies (Pizzi et al., 2020). The World Business Council for SDG asserts that such transformation establishes new sustainable and inclusive markets, generating potential up to $15 trillion, particularly in energy, urban sustainability, and agricultural and food production.

Blockchain Technology (BCT) is a modern technology that establishes a basis for developing innovative Business Models (BM) (Lotfi et al., 2021; Gebauer et al., 2020). BMs that eliminate middlemen within an ecosystem of participants and prioritize security above efficiency are noteworthy. This alteration in a venture's BM negatively affects several sectors. Current BCT in the financial industry obviates the necessity for reconciling and intermediaries, facilitating immediate interactions between trade parties.

BCT allows users to consistently track their assets and independently execute operations while offering a secure framework that is fault-tolerant, robust, and perpetually accessible. Emerging BCTs, such as VeriPart from Moog in the production industry, provide improved safety and durability to bolster trust in 3D-printed components. Motivated by these companies and anticipating enhanced commercial value, many businesses consider BCT a fundamental technology. BCT authenticates traded items, enables decentralization, and improves operational effectiveness, impacting existing BM and fostering the creation of new ones. While the influence of BCT on BM is significant, existing research mainly emphasizes technological dimensions and practical applications. Examples demonstrate the transformation approach and suggest how BCT fundamentally changes operations and service delivery across several sectors.

There needs to be an empirical study on how BCT might transform current BM and establish the foundation for new ones. Theoretical emphasis needs to be placed on the impact of BCT on BM, and BCT enterprises continue to need to provide the anticipated commercial value. Companies must comprehend how BCT might give commercial value to their specific company models. Whether BM has demonstrated success for this emerging foundational technology is still being determined.

This article examines how BCT and its characteristics might facilitate new SBMs. The paper is original since it aligns with an underexplored research niche. The extent to which BCT will significantly influence the creation of SBMs remains to be completely unexamined. The essay seeks to enhance understanding in this domain by examining 20 case stories contributing to theory and application while presenting novel difficulties for future study. The findings about SBM-related applications connect academia and practice, warranting an investigation into the insights gained by executives and scholars adept at facilitating innovation transfer to enterprises.

II. BACKGROUND

2.1 SBMs

A BM delineates how a corporation generates, acquires, and disseminates value for consumers and, broadly, those it serves. Initially, the focus was primarily on comprehending how to establish and cultivate competitive advantages and financial benefit for the business and its investors; however, an alternative model has grown, necessitating organizations to adopt a more expansive notion of worth that incorporates sustainability. In this changing environment, SBMs were established to integrate economic gain and profit with the advantages for each stakeholder.

BMs can play a significant role as facilitators of sustainability. In contrast to the concept of traditional BM and transaction expenses, which necessitate organizations to delineate the value suggestion by evaluating businesses, procedures, consumers, goods, assets, and vendors, SBM

mandates the inclusion of environmental or social value as essential components of the value suggestion or creation of value procedure.

SBMs signify a nascent study area grounded on the theoretical frameworks of BM innovation, stakeholder engagement, and networking. SBMs must establish value systems with novel objectives, tactics, and governance structures. SBMs require greater attention to each stakeholder's interests, obligations, and consequences.

This implies that suppliers assume accountability for their local systems, consumers are encouraged to purchase refurbished or recyclable goods, and businesses advocate for professionally impactful initiatives or develop sustainable BM (Fobbe & Hilletofth, 2021). Despite the increasing attention, the literature is subject to rigorous scrutiny, revealing two significant strands of concern. Researchers are advocating innovative functional designs for sustainable BM (Barth et al., 2021). Some scholars formulate novel theoretical linkages by examining free innovation and collaborative business.

Initially, addressing the ecological and social awareness and issues afflicting our world, the authors interrogate the interconnections among BM variables by advocating for advanced frameworks focused on sustainability, wherein the company's impact on society is a fundamental criterion for evaluation and monitoring. The outcomes thus far are encouraging. In the case of SBMs, value creation entails enhancing individuals' well-being by promoting cooperation, moderation, balance, and humanism.

In the second instance, scholars evaluate SBMs as comprehensive instruments that foster beneficial discoveries across several fields. This encompasses corporate and social transformations, modifications in goods or procedures creativity, and integrating technological advances into the company with sustainable objectives.

2.2 BCT and SBMs

BCT is seen by many as a technology with significant potential for application in company administration. The scholars are intrigued by its attributes of immutability, genuineness, decentralized management, and precision (Wang et al., 2024). These technical issues manifest as a chance to enhance stakeholders' confidence and openness regarding corporate data. BCT is a facilitator of organizational sustainability owing to its accountability, security, and resistance to data manipulation.

By minimizing agents, the technology can decrease transaction expenses. The authors illustrate the decrease in transaction expenses through enhanced social proof provided by business enterprises, especially within service sectors, resulting in greater accessibility to goods and services for individuals. BCT plays a role in the financial viability of organizations.

The financial sector maintains intimate connections with the ecological domain. Despite the scarcity of empirical data, BCT has the potential to drive innovative green BM aimed at minimizing energy usage and mitigating the environmental imprint. Its distributed database capability renders climate-neutral initiatives visible to participants. The United Nations SDGs enable customers to engage with and comprehend the climate crisis and the measures corporations implement to mitigate it. BCT has the potential to advance the attainment of the SDGs from a sustainability perspective by fostering a transformation in economic models,

particularly concerning SDGs #8 (Cost-effective and Clean Power), #112 (Smart Cities and Economy), #13 (SDG in the Supply Chains (SC)), and #14 (Weather Actions). While universal, the potential of this innovation requires empirical validation and exemplary instances of application to facilitate future scale.

The attributes of distributed and decentralized ledgers enhance social engagement, long-term viability, and creativity. The research must refrain from excessive promotion and unrealistic commitments to technology. During COVID-19, BCT has demonstrated its capacity to expedite the adoption of the SDGs, including #4 (Good Healthcare and Well-being) and #12 (Reduced Inequality). BCT can promote socially responsible BM despite existing knowledge deficiencies. This is feasible because it enhances confidence among participants and supporters, enabling the technology to monitor expenditures, assess outcomes, and attract fresh funding.

Implementing BCT can enhance, both directly and informally, the dissemination of knowledge about Intellectual Capital (IC), which encompasses human, interpersonal, and structural assets. This technique enables knowledge-decentralized management, making it feasible (Nazir et al., 2023). BCT has potential even in politically charged domains such as healthcare. For instance, pharmaceuticals cannot be forged due to the decentralized and secure record, enabling sufferers to receive the required dosage without deception. BCT influences medical care by fostering confidence, traceability, and openness, promoting a decentralized health record platform that facilitates the incorporation of medical, corporate, and administrative results. Applications powered by BCT contribute to society's sustainability.

III. BC-BASED SCM MODEL

The SCB concept integrates intra- and inter-level affiliate enterprises to optimize the utilization of commodities or assets. It provides an essential framework for directing SC Management (SCM) to improve investments' effectiveness and financial return. There is a reduction in detrimental ecological, community, and economic effects.

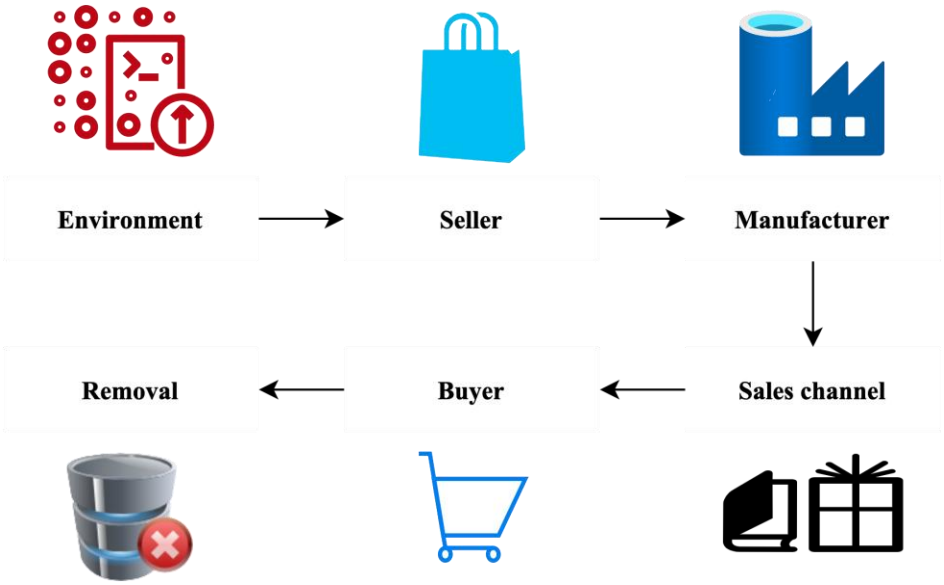


Figure 1(a): LBM Model

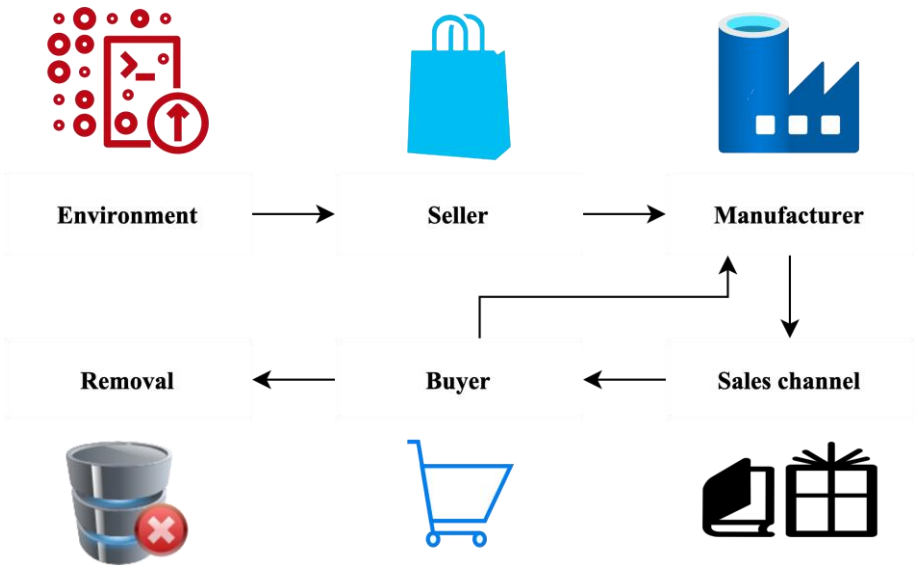


Figure 1(b): CLBM Model

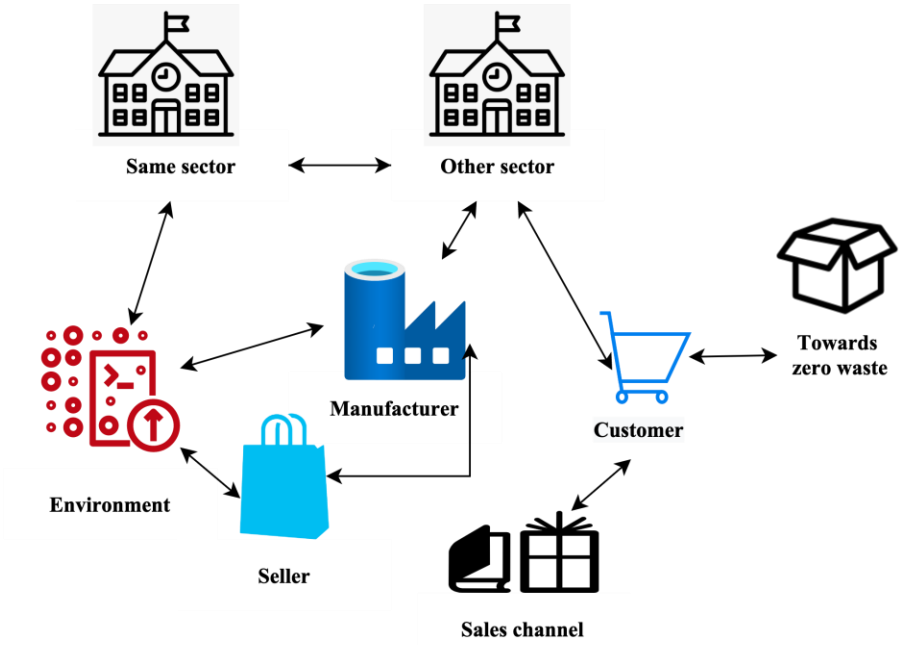


Figure 1(C): SCBM Model

Figure 1 illustrates that Circle SCM (CSCM) seeks to play a pivotal role in advancing circular SC. Figure 1 presents a comparison among the SC-based BM (SCBM) (illustrated in Figure 1(c)), the standard Linear BM (LBM) (represented in Figure 1(a)), and the Closed-Loop BM (CLBM) (depicted in Figure 1(b)). A linear SCM system utilizes natural assets and aims to discard goods, packaging materials, and waste produced at various stages in the SC.

Unwanted items are frequently stored in areas. The closed-loop SC promotes environmental sustainability by enabling the return of products and packaging materials to the seller based on their need. Cost recovery in the closed-loop SC is limited to operations inside the initial seller and excludes subsequent SC. More participants in the marketing team will be engaged.

A closed SC produces considerable waste due to the restricted viability of recycling or recovering all discarded items within a single SC—a CSC profits from waste by working with similar or varied industries. CSC is intended to eliminate garbage since it is meant to safeguard and recycle land continually, enhancing the economy and the environments in which it is implemented. CSCs demonstrate two types of material flow: the main and the circular transfer of resources, as seen in Figure 1(c). In linear and closed-loop SCM, the principal resource flow is characterized by the sequential transfer of commodities. The circular flow illustrates the perpetual movement and change of products, resources, and power as they are recycled, conserved, repurposed, rectified, and reprocessed.

An extensive evaluation was performed to determine the efficacy of the suggested SCBM framework by meticulously analyzing the cases. This article employs examples to examine contemporary trends, thoroughly studying particular solutions. After the research review, the next phase involved choosing the businesses for the study based on their fundamental historical context. A specific screening strategy was established since the case studies relate to educational theory rather than an empirical research approach.

The primary criterion for evaluation is the degree to which the business's operational structure is connected to loop closing, acceleration, intensification, reduction looping, and deconstruction. A closed-ended assessment inquiry has been conducted to gather cross-sectional data from 280 SMEs. They were chosen to explore market potential utilizing the CE reasoning, which entails the integration of the SCBM model with CSCM to promote sustainable growth.

Each chosen SME provides a basis for comprehending the elements and functions of CE, irrespective of the specific industries and BM engaged. The data assessment primarily focused on informal conversations with crucial SME sources. The data investigation encompassed interviews conducted by business sustainability. The research's limitation has been mitigated by augmenting the interview findings with written reports and customer databases. Recruiters frequently sought exact meanings for broad statements. The key sources were selected based on availability and thorough comprehension of each client's BM. The discussions encompassed inquiries on the respondents' attributes and viewpoints aligned with their organizations' SCBM model. The study mainly investigated three facets: (i) the value of the enterprise, including the social, ecological, and financial benefits it seeks to provide; (ii) the strategies for development and distribution aimed at terminating the product's perpetual cycle; and (iii) the degree of engagement exhibited by diverse stakeholders. The acquired data is evaluated qualitatively according to sustainability standards.

Strategies for Managers and Practitioners

Emerging disruptive technologies, such as BCT and the Internet of Things (IoT), can enhance the collective accountability of individuals and organizations. The recommendations are designed for professionals and leaders who will play pivotal roles in implementing BCT –IoT-integrated architecture within organizations to tackle green procurement concerns for SBM.

- Each industry or organization will possess distinct requirements regarding transaction tracking and SC research. It is prudent to comprehend the BCT-IoT application within the sector first and formulate a plan of action accordingly.

- BCT -IoT-integrated design is inherently complex, including several partners within and outside the organization. Professionals must create a comprehensive deployment plan to understand the flow of data and resources throughout the system.
- Finance serves a significant role in the implementation of novel technologies. A comprehensive transition to BCT IoT necessitates careful planning about expenditure and returns on investment. Stories of successful deployments and the problems organizations encounter benefit executives in comprehensive planning.
- BCT and IoT necessitate rigorous staff training to ensure organizations' effective and seamless operation. Practitioners can facilitate workshops and conferences for staff to familiarize them with the technology before adoption.
- Legal and governmental complications arise since it necessitates electronic agreements and other legal documentation from all parties involved in the SC. The attorneys must assess the legal papers and confirm compliance with government regulations.

IV. RESULTS

The study employed a survey technique to collect data on SMEs engaged in production-related green SC management activities. The participants received surveys and a brief overview of the research's objective. The respondents, including management individuals from SMEs, needed to know about BCT. A closed-ended questionnaire poll was administered to collect longitudinal information from 280 SMEs. A total of 450 surveys were distributed, and 290 were returned. Twenty of the submitted queries must be completed or correctly completed. The study included two hundred sixty-five surveys, reflecting a mean response rate of 68.7%. Multiple BM has been assessed for comparative analysis as follows:

- LBM
- CLBM
- SCBM

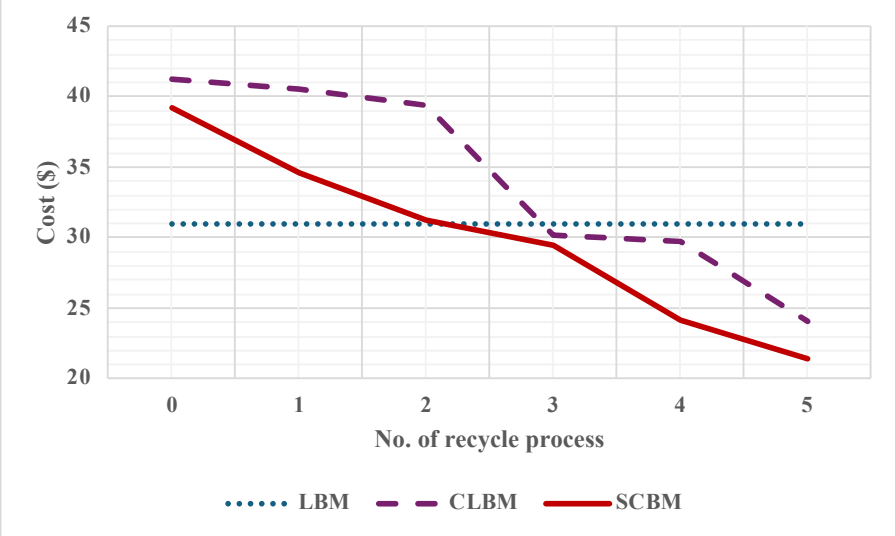


Figure 2: Cost Evaluation of BM Using BCT

Figure 2 illustrates the cost assessment of recycling procedures across different BM utilizing BCT. Beginning at 31.4 with zero recycling phases, LBM prices remain unchanged. CLBM costs 41.5, while the suggested cost of SCBM is 39.4. Reusing is financially beneficial as the costs of all BM diminish with increased recycling regularity. At 0.25 recycling phases, LBM continues at 31.4, CLBM decreases to 35.2, and Suggested SCBM decreases to 36.3, which is more than CLBM. Following a single recycling cycle, LBM remains at 31.4, CLBM decreases to 37.4, and the planned SCBM declines to 30.5. LBM remains at 31.4, CLBM decreases to 31.3 and Suggested SCBM declines to 24.3 following 1.8 cycles. LBM continues at 31.4, CLBM decreases to 21.1 and Suggested SCBM declines to 23.2 over two cycles. At 3.2 cycles, the LBM value remains at 31.4, the CLBM value decreases to 22.6, and the suggested SCBM value declines to 28.2. Following three recycling phases, the LBM remains at 31.4, the CLBM decreases to 22.3, and the predicted SCBM declines to 23.5. After finishing 4.5 cycles, LBM stays at 31.4, CLBM decreases to 27.3, and planned SCBM declines to 22.5. Following four recycling cycles, LBM persists at 31.4. CLBM declines to 22.0, and the Proposed SCBM decreases to 19.4. Generally, the suggested SCBM consistently incurs less expenditure than the CLBM as reusing cycles escalate.

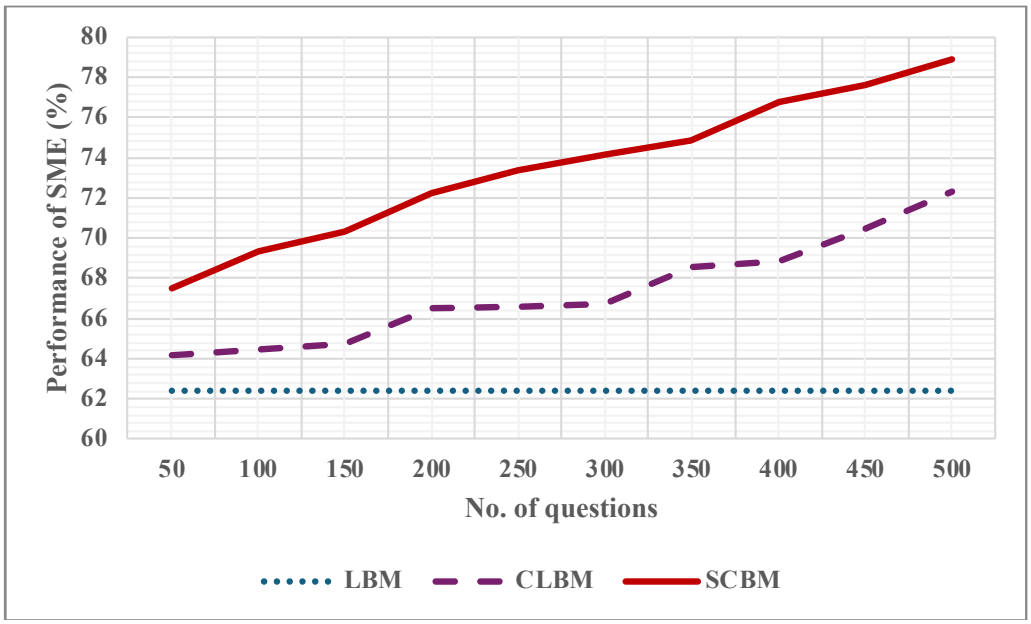


Figure 3: Performance Analysis of SMEs Using BM with BCT

Figure 3 depicts the general efficiency of SMEs (%) in terms of the number of survey questions across various BM utilizing BCT. The performance of the LBM model is consistently 64%, regardless of the number of questions, indicating no enhancement with increased question count. The CLBM model enhances its precision from 70% with 52 inquiries to 92% with 360 inquiries, decreasing to 88% with 450 inquiries. The CLBM model has advantages from an increased number of questionnaires but in a restricted quantity. The SCBM model effectively performs all question quantities, achieving 70% accuracy with 60 and 93% accuracy with 450 inquiries. The consistent upward trend indicates that the SCBM methodology utilizes survey information to enhance the efficiency of SMEs. The SCBM paradigm surpasses the LBM and CLBM methods at all levels, particularly at 250 inquiries (86%) and higher. The adaptability and utilization of survey data to enhance SME efficiency are commendable.

V. CONCLUSION

This research presents a SCB model that enhances SME performance through BCT. A closed-ended survey was employed to gather cross-sectional data from 280 SMEs. CSCM integrates CE into SCM, providing a novel and persuasive perspective on SC sustainability. The circular economy strategy in SCM has offered financial and environmental benefits to SMEs. All industries now emphasize technology due to Industry 4.0. The emerging phenomena of BCT hold significant promise in enhancing SME activities. The suggested SCBM consistently exhibits lower costs and improved efficiency relative to CLBM when the quantity of recycling stages and survey inquiries increases. This underscores the cost-effectiveness and financial viability of the suggested SCBM framework when employing CE and CSCM methodologies to reduce expenses and enhance the efficiency of SMEs.

This research underscores the necessity of heeding recent appeals for enhanced research into the impact of the latest industrial technologies on corporate sustainability, as articulated in the Introduction. Future studies must examine how BCT practically improves sustainable company model creation in greater depth. It is acknowledged that BCT research must be conducted using empirical methodologies, even within IC. BCT enhances consumer trust and diminishes transaction expenses by providing accountability, safety, and immutability of information, which is especially beneficial in agri-food businesses.

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