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Virtuous Innovations and the Circular Economy: A Chronicle of Quantifying Sustainability-Oriented Innovations in the Circular Economy

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Abstract

The proposed paper explores the quantifying techniques scholars use globally to measure Sustainability-oriented Innovations in the circular economy. This conceptual paper highlighted the techniques and proposed formulas to measure the impact of innovation on the Circular Economy. The methods used to collect data are desk study and archival research. This paper collects past literature to explore as many quantifying techniques as possible in circular methods. Subsequently, previous literature suggests a hypothesis that can be explored further in a quantitative research design, and it is developed to study the link between sustainability-oriented innovations and the Circular economy. Furthermore, the paper's purpose is not constrained to identify the relations only. It proposes methods of calculations that could be utilized to present factual results that can be benchmarked. This paper is an exploratory study that explores deep in the literature to grasp quantifying techniques that scholars with superior practical implications standardize. The quantifying techniques are either found or interpreted from the literature through the units of measurement in formulas.

Keywords: *Sustainability Oriented Innovations, Circular Economy, Developed Formulas, Quantifying Techniques*
JEL Classifications: Q01, Q56, O33, O44 & M15.

Introduction

Sustainability-oriented innovation (SOI) is defined as achieving sustainable development with the triple bottom line focused innovation practice (Reyes-Rodríguez, Contreras-Pacheco, & Arias, 2023). Moreover, SOI is also defined as a subset of innovation that primarily focuses on reducing the negative impacts of innovation in the social and environmental pillars. Moreover, SOI is also defined as a subset of innovation that mainly focuses on reducing the negative effects of innovation in the social and ecological pillars (Yu, Zheng, Lin, & Yuan, 2023). Technically, SOI commercially is innovation in the product, service or product-service that can trace the sustainability impacts and measure them either qualitatively or quantitatively(Depetris-Chauvin, Fernandez Olmos, Hu, & Malorgio, 2023). On the other hand, Circular Economy (CE) focuses on the 3Rs system of (Reduce, Reuse and recycle). It considers waste an additional economic resource that, if not dealt with properly, can halt the 3Rs Process (Kirchherr, Yang, Schulze-Spüntrup, Heerink, & Hartley, 2023).

Research Questions

- What is the relation between SOI and CE?
- What methods can be used to quantify the impacts of Sustainability Oriented Innovation on Circular Economy in the past literature?

Research Objectives

- Exploring the positive or negative relation
- A universal formula or unit to be adapted and proposed based on past literature.

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Literature Review

The dimensions behind SOI can be defined as behavior, transformation, and the business model. These three dimensions can drive the SOI and the CE business model (Koval et al., 2022). Furthermore, the author established a framework to examine the efficiency of SOIs in CE, enabling adopting technologies and opting for sustainable raw materials to develop SOIs. However, this model proposes a framework to determine without using measurement units, supporting the urgency of the research problem. Subsequently, measuring the SOI impacts can be done through a proposed survey that divides the questions into three major aspects of Product innovation, process innovation, and sustainable innovation measures against the three pillars of sustainability. The respondents can answer the following questions on a Likert scale, which will be analyzed statistically(Calik, 2024). It is a major progress in the field as it adds quantifiable measurements to the impacts of SOI by deriving questions from past studies. However, the units are not yet mentioned as statistical tools, and the Likert scale is vague and could be interpreted differently.

Quantifying SOI can be similar to measuring the impact of innovation on a macroeconomic level. Alternatively, instead of measuring the total patent applications is proven to be insignificant. Thus, transforming the formula total of local and foreign applications empirically correlates to higher economic growth (Law et al., 2020).In contrast to prior models, this empirical study shows insignificance to prior formulas and proposes a newer formula showing a positive economic increase. Using a regression analysis, a Chinese quantitative study shows a negative correlation between the cost of equity and green innovations (Alkebsee, Habib, & Li, 2023). Furthermore, the cost of equity capital could decrease as higher investments occur. This paper can project to policymakers that adopting green innovations might be costly initially.

SOI and Circular Economy Quantifications

This study finds several units and recommends the implementation of the units to unify the impact measurements. The research of SOI and CE should expand to various sectors as the literature available is not comprehensive enough. The previous research took place in developed countries, mostly Western, and it is recommended to study the developing countries as the control variables that range from technology, laws, and social norms vary from the developed countries (Koval et al., 2022). Moreover, developing countries could be a suitable research subject as sustainable frameworks can influence policymakers and SMEs into contributing to a CE by adopting SOI practices through the mediating factor of technology (Reyes-Rodríguez et al., 2023). By critically analyzing the gaps, the researcher noticed that there is a lack of literature in developing countries stated recently by other researchers in 2022. The dimensions of CE favored an economic pillar rather than the other two, which creates a narrow practical implementation. However, it is recommended to study the CE at a micro and macro level (Kristensen & Mosgaard, 2020).

The positive relationship between SOI and CE indicates that an increase in the SOI lead to a rise in the adoption and development of the CE. The innovation diffusion theory supports the hypothesis as it delves into the knowledge and diffusion of innovative practices, like SOI, that have been influenced by several factors (Vann Yaroson et al., 2024). The CE is one of the contexts in SOI that requires innovative approaches that reduce resource consumption management, enhance resource recovery, and improve environmental performance. Moreover, the resource-based view theory is also applied to identify sustainable resources and definite capabilities in improving competitive advantages (Ul-Durar, Awan, Varma, Memon, & Mention, 2023). SOI could lead to developing new opportunities, reducing costs, and creating value efficiently.

Additionally, the ecological modernization theory determines the transformative changes in the production and consumption patterns to fulfill sustainability goals (Schmied, Krings, & Koch, 2024). SOI seems to promote eco-friendly activities that lead to adopting circular economy activities. It is deduced that SOI contributes to ecological modernization by managing the long-term aspects for environmental and economic advantages. Santa-Maria, Vermeulen, and Baumgartner (2022) further supported our hypothesis by stating that an increase in SOI corresponds to an increase in the adoption and deployment of CE-related practices.

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There is an overarching finding for measuring SOI impacts on the CE . SOI manages the industry's financial, environmental, and social performances that lead to efficiently utilizing the resources Therefore, SOI develops effective products, relevant services, and processes aligned with the CE principles. Waste reduction activities such as recycling, reusing processes, and remanufacturing are interpreted to be major CE principles from the previous text. Therefore, Ren and Albrecht (2023) stated that the potential innovations could promote resource efficiency and waste reduction. Due to the presented arguments, the hypothesis proposed is:

H1: There is a positive association between SOI and CE

Methods

Method	Formula	Source	Economy
Resource Efficiency (RE)	*Total amount of energy and raw materials/ Total output*	(Di Maio et al., 2017)	CE
Life cycle Analysis	*Raw materials extraction - Manufacturing or Assembly - Transportation and distribution - Usage - Disposal and recycling than back again to raw materials extraction*	(Nassaar et al., 2024)	CE
Circularity Rate	*Number of circular materials used/ Total amounts of materials used*	(Kostakis & Tsagarakis, 2022; Skare et al., 2024)	CE
Waste Reduction	*Total amount of waste/ Total units*	(Aramyan et al., 2022; Lins et al., 2021; Alves, 2023)	CE
Carbon footprints	*Comparative analysis of the emissions before and after SOI implementation*	None	CE
Recycling rates	*Amount of quantity recycled/ potential amount that can be recycled*	(Banacu et al., 2019)	CE
Productivity Rate	*Total output produced/Total input used for productivity*	(Sartal et al., 2020)	CE
Energy Efficiency	*Measure the useful energy output/total energy output*	(Bowman et al., 2020)	CE
Environmental Impact Reduction	*Difference in Environmental Impact CE-PE*	(Li, Song, Cai, Bian, & Mohammed, 2022)	CE
Cost Benefit Analysis	*Net Profit=Total Benefits from SOI – Total Cost associated with implementing SOI*	(Depetris-Chauvin et al., 2023)	CE
Material Recovery Rate	*Measure the amount of material recovered/measure the total material used*	(Jang et al., 2020)	CE
Water Use Efficiency	*Measure the Output Produced/Measure the amount of water used*	• (Guerra-Rodríguez, Oulego, Rodríguez, Singh, & Rodríguez-Chueca, 2020) • (Kakovitch & O'Hara, 2021)	CE

The process of calculating the impacts of SOI on the CE has been analyzed. This conceptual paper, not requiring secondary quantitative data to support the hypothesis, can be studied for primarily in a consultancy and advisory role. The impact was positive if the resource efficiency rate was higher than the previous rate after implementing SOI. If the RE was less than the previous rate, it might have indicated a negative relationship between SOI and CE. In brief, the higher the RE rate, the better, which was computed as

[Current RE - Previous RE = either positive or negative difference].

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Subsequently, the Life Cycle Analysis was calculated similarly, using comparative analysis to identify the impact. Using LFA, if the amount disposed of was higher than the previous year, it contributed positively to the CE, and if less, it reduced the recycling amount, which harmed the CE process. It seemed that the Circularity Rate and Waste Reduction aimed to increase the circularity amount as it indicated that the material would be reused, causing less new material use. If the CR was growing, the better the impact on CE, and if the rate was reduced, it might have indicated harm to the CE, which was computed as

[Current CR - Previous CR = either positive or negative difference].

Moreover, if the wastage amount in any unit was less than the previous year, it impacted CE positively. Waste reduction was directly related to CE performance. Similarly, the recycling rate also had a positive relation to CE. The higher the amount of recycling, the higher the impact on CE, which was computed as [Current RR - Previous RR = either positive or negative difference], and for the waste reduction, it was similarly calculated as

[Current WR - Previous WR = either positive or negative difference].

However, the carbon footprint process was deeply environmental; thus, the process was out of the research scope. The paper indicated that if the implementation of SOI reduced the carbon footprint, the impacts on CE were considered positive, computed as

[Current CF - Previous CF = positive or negative difference].

The researcher proposed formulas based on simple subtraction and division methods, which could be done manually or by simple statistical outlets, indicating how a comparative analysis method could be initiated.

Conclusion

In conclusion, this conceptual paper outlines a comprehensive framework for assessing the impacts of Sustainable Organizational Innovation (SOI) on the Circular Economy (CE) through various metrics. Key indicators such as Resource Efficiency (RE), Life Cycle Analysis (LCA), Circularity Rate (CR), Waste Reduction (WR), Recycling Rate (RR), and Carbon Footprint (CF) are evaluated using a straightforward subtraction method. This method facilitates a clear understanding of whether the implementation of SOI has positively or negatively influenced CE.

Organizations can gain valuable insights into their environmental and operational performance by employing these metrics, thus enabling informed decision-making and strategic planning. Additionally, formulas for Productivity Rate (PR), Energy Efficiency (EE), Environmental Impact Reduction (EIR), Cost-Benefit Analysis (CBA), Material Recovery Rate (MRR), and Water Use Efficiency (WUE) provide a holistic view of the efficiency and sustainability of operations.

Although quantitative data is not mandated for this paper, the proposed methods offer a robust approach for future empirical studies and consultancy applications. Adopting SOI can significantly enhance CE practices, promoting sustainability, reducing waste, and fostering economic and environmental benefits. This paper serves as a guide for organizations seeking to integrate sustainability into their core operations effectively.

Theoretical Implications

This paper addresses contemporary gaps in the literature related to Sustainability-oriented Innovations (SOI) and the Circular Economy (CE). Koval et al. (2022) highlighted the lack of SOI research in developing countries; this paper fills that gap by providing 12 formulas and a practical framework for measuring SOI impacts using simple mathematical formulas. Kristensen and Mosgaard (2020) criticized the narrow focus on the economic pillar; this study introduces formulas to quantify SOI impacts on CE

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measures instead of fiscal units, offering practical implications for environmental pillars.The hypothesis clarifies SOI's relationship with CE, addressing the research objectives. The paper presents standardized formulas from past literature to meet these objectives. The study focuses on simple, adaptable mathematical units, excluding the social pillar from its scope but enhancing understanding of SOI's economic and environmental impacts.

Reflections and Future Perspectives

Sustainability-oriented Innovations (SOI) are vital for economic advancement, requiring scaling and measurement within the Circular Economy (CE). Current research identifies a gap in quantifying these impacts, addressed through adjusted traditional financial tools and specific formulas, highlighting differences before and after SOI implementation (Ren & Albrecht, 2023). This process assesses resource utilization and economic impacts of SOI and CE (Perrotti, Verma, Srivastava, & Singh, 2021). The paper proposes formulas to measure the economic effects of SOIs, tailored to various contexts, providing quantitative measures of financial returns, costs, and benefits (Furness, Bello-Mendoza, & Chamy Maggi, 2023). These formulas support informed decisions on resource allocation (Dwivedi, Sassanelli, Agrawal, Gonzalez, & D'Adamo, 2023).

Product circularity and global warming indicators are used to assess component circularity (Diez-Cañamero & Mendoza, 2023). The research emphasizes fiscal units for competitiveness, linking sustainability and economic performance (Dey et al., 2022).A modified Leontief-Ford Model includes environmental costs, suggesting governments use it to generate a GDP with environmental components (Potravny, Gusev, Stoykov, & Gassiy, 2017). The paper calls for updating macroeconomic indicators to prevent social and ecological crises. The study concludes that fiscal-based formulas dominate CE calculations, with traditional financial methods still prevalent over circularity indexes.

References

Alkebsee, R., Habib, A., & Li, J. (2023). Green innovation and the cost of equity: evidence from China. China Accounting and Finance Review, 25(3), 368-395.

Alves, E. C., dos Santos Alves, I. H., Soares, B. B., Borges, A. F., Jalal, A., Jani, A. D., ... & Nogueira, T. A. R. (2023). Resource recovery of biological residues from the Brazilian poultry industry in mitigating environmental impacts: A life cycle assessment (LCA) approach. Journal of Cleaner Production, 416, 137895.

Aramyan, L., Grainger, M., Logatcheva, K., Piras, S., Setti, M., Stewart, G., & Vittuari, M. (2021). Food waste reduction in supply chains through innovations: A review. Measuring Business Excellence, 25(4), 475–492. https://doi.org/10.1108/MBE-11-2019-0105

Banacu, C. S., Busu, M., Ignat, R., & Trica, C. L. (2019). Entrepreneurial innovation impact on recycling municipal waste: A panel data analysis at the EU level. Sustainability, 11(18), 5125. https://doi.org/10.3390/su11185125

Bowman, G., Ayed, L., & Burg, V. (2022). Material and energy flows of industrial biogas plants in Switzerland in the context of the circular economy. Bioresource Technology Reports, 20, 101273.

Calik, E. (2024). A validated measurement scale for sustainable product innovation performance. Technovation, 129, 102882.

Depetris-Chauvin, N., Fernandez Olmos, M., Hu, W., & Malorgio, G. (2023). Costs and benefits of sustainability-oriented innovation in the agri-food industry: A review. New Medit, 22(3), 23-45.

Dey, P. K., Malesios, C., Chowdhury, S., Saha, K., Budhwar, P., & De, D. (2022). Adoption of circular economy practices in small and medium-sized enterprises: Evidence from Europe. International Journal of Production Economics, 248, 108496.

Di Maio, F., Rem, P. C., Baldé, K., & Polder, M. (2017). Measuring resource efficiency and circular economy: A market value approach. Resources, Conservation and Recycling, 122, 163–171. https://doi.org/10.1016/j.resconrec.2017.02.009

Diez-Cañamero, B., & Mendoza, J. M. F. (2023). Circular economy performance and carbon footprint of wind turbine blade waste management alternatives. Waste Management, 164, 94-105.

Dwivedi, A., Sassanelli, C., Agrawal, D., Gonzalez, E. S., & D'Adamo, I. (2023). Technological innovation toward sustainability in manufacturing organizations: A circular economy perspective. Sustainable Chemistry and Pharmacy, 35, 101211.

Furness, M., Bello-Mendoza, R., & Chamy Maggi, R. (2023). The Biofactory: Quantifying Life Cycle Sustainability Impacts of the Wastewater Circular Economy in Chile. Sustainability, 15(22), 16077.

Guerra-Rodríguez, S., Oulego, P., Rodríguez, E., Singh, D. N., & Rodríguez-Chueca, J. (2020). Towards the implementation of circular economy in the wastewater sector: Challenges and opportunities. Water, 12(5), 1431.

Jang, Y.-C., Lee, G., Kwon, Y., Lim, J.-h., & Jeong, J.-h. (2020). Recycling and management practices of plastic packaging waste towards a circular economy in South Korea. Resources, Conservation and Recycling, 158, 104798.

Kakovitch, T. S., & O'Hara, S. (2021). Water and the Circular Economy: Learning from Nature. Sustainability, 13(22), 12597.

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Kirchherr, J., Yang, N.-H. N., Schulze-Spüntrup, F., Heerink, M. J., & Hartley, K. (2023). Conceptualizing the circular economy (revisited): an analysis of 221 definitions. Resources, Conservation and Recycling, 194, 107001.
Kostakis, I., & Tsagarakis, K. P. (2022). The role of entrepreneurship, innovation and socioeconomic development on circularity rate: Empirical evidence from selected European countries. Journal of Cleaner Production, 348, 131267. https://doi.org/10.1016/j.jclepro.2022.131267
Koval, V., Arsawan, I. W. E., Suryantini, N. P. S., Kovbasenko, S., Fisunenko, N., & Aloshyna, T. (2022). Circular economy and sustainability-oriented innovation: Conceptual framework and energy future avenue. Energies, 16(1), 243.
Kristensen, H. S., & Mosgaard, M. A. (2020). A review of micro level indicators for a circular economy–moving away from the three dimensions of sustainability? Journal of Cleaner Production, 243, 118531.
Law, K. L., Starr, N., Siegler, T. R., Jambeck, J. R., Mallos, N. J., & Leonard, G. H. (2020). The United States' contribution of plastic waste to land and ocean. Science advances, 6(44), eabd0288.
Li, J., Song, G., Cai, M., Bian, J., & Mohammed, B. S. (2022). Green environment and circular economy: A state-of-the-art analysis. Sustainable Energy Technologies and Assessments, 52, 102106.
Lins, M., Zandonadi, R. P., Raposo, A., & Ginani, V. C. (2021). Food waste on foodservice: An overview through the perspective of sustainable dimensions. Foods, 10(6), 1175. https://doi.org/10.3390/foods10061175
Nassar, A. M., Arafa, W. A., Ashammari, K., Moustafa, S., Alsirhani, A. M., & Hasaneen, M. F. (2024). A new green catalyst and antimicrobial agent derived from eco-friendly products of camel bones: Synthesis and physicochemical characterization. Biomass Conversion and Biorefinery, 1–19. https://doi.org/10.1007/s13399-024-03701-3
Perrotti, D., Verma, P., Srivastava, K., & Singh, P. (2021). Challenges and opportunities at the crossroads of Environmental Sustainability and Economy research. Environmental sustainability and economy, 345-360.
Potravny, I., Gusev, A., Stoykov, V., & Gassiy, V. (2017). Modification of the Leontief-Ford input-output model for the green economy goals and environment protection. Journal of Geoscience and Environment Protection, 5(11), 15.
Ren, Q., & Albrecht, J. (2023). Toward circular economy: The impact of policy instruments on circular economy innovation for European small medium enterprises. Ecological Economics, 207, 107761.
Reyes-Rodríguez, J. F., Contreras-Pacheco, O. E., & Arias, O. P. C. (2023). Sustainability-oriented innovations and value creation in SMEs: An illustration in the Colombian context. Management, 21(3), 777-791.
Santa-Maria, T., Vermeulen, W. J., & Baumgartner, R. J. (2022). How do incumbent firms innovate their business models for the circular economy? Identifying micro-foundations of dynamic capabilities. Business Strategy and the Environment, 31(4), 1308-1333.
Sartal, A., Ozcelik, N., & Rodriguez, M. (2020). Bringing the circular economy closer to small and medium enterprises: Improving water circularity without damaging plant productivity. Journal of Cleaner Production, 256, 120363.
Schmied, S., Krings, U., & Koch, M. (2024). Controlling of the Circular Economy. In Finance in Crises: Financial Management Under Uncertainty (pp. 111-122): Springer.
Skare, M., Gavurova, B., & Kovac, V. (2023). Investigation of selected key indicators of circular economy for implementation processes in sectorial dimensions. Journal of Innovation & Knowledge, 8(4), 100421. https://doi.org/10.1016/j.jik.2023.100421
Ul-Durar, S., Awan, U., Varma, A., Memon, S., & Mention, A.-L. (2023). Integrating knowledge management and orientation dynamics for organization transition from eco-innovation to circular economy. Journal of Knowledge Management, 27(8), 2217-2248.
Vann Yaroson, E., Chowdhury, S., Mangla, S. K., Dey, P., Chan, F. T., & Roux, M. (2024). A systematic literature review exploring and linking circular economy and sustainable development goals in the past three decades (1991–2022). International Journal of Production Research, 62(4), 1399-1433.
Yu, G., Zheng, Q., Lin, X., & Yuan, K. (2023). Sustainability-Oriented Low-Carbon Innovation in SOEs: A Case Study of Shanghai Metro. Sustainability, 15(23), 16216.