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The Role of Data Analytics and Sustainable Circular Economy in Developing Countries

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ABSTRACT

In the twenty-first century, data analytics has become a vital tool in decision-making. Modern companies and organisations create enormous volumes of data, which need for sophisticated ways to analyse. Statistics help companies make data-driven decisions by organising, summarizing, and interpreting data. 21st-century enterprises, organisations, and people generate more data than ever. Due to rapid technological advancement and growing data, companies must make data-driven choices. As such, the place of data analytics is the era of digital economy cannot be overemphasize. This paper essentially review these roles in achieving sustainable circular economy in developing countries. The study was based solely on secondary data elicited from the review of previous studies on the subject being investigated. The examined the concepts and benefits of circular economy, the challenges in implementing circular economy in developing countries, as well as the concept, impact and role of data analytical impact on achieving sustainable circular economy. The overall findings from this study indicates that indeed, data analytics play important role in achieving sustainable circular economy in developing countries and thus recommends the system theory approach to circular economy where all parts are connected in somewhere to enhance effectiveness and reduce cost. Such connection can only be efficient through data analytics.

INTRODUCTION

Technology disruption is one of the most drivers speedy change in many organisations. No sooner has Industry 4.0 was introduced, Industry 5.0 is already being implemented in most companies. Industry 5.0, which incorporates use of Big Data and the Internet of Things (IoT) from Industry 4.0 as well as the triple bottom line of sustainability into all business operating models, has already begun to be implemented by most businesses. Remember that "big data" describes very large datasets that are beyond the capabilities of conventional data processing tools. Scholars have recently realised that digitising the supply chain might aid in the fight against environmental challenges. One UN sustainability objective is circularity in company operations (Nayal et al 2022; Beta et al 2023; Awan et al 2021). The BCG economic model's circular economy maximises value, efficiency, and environmental impact across a product's life cycle (Sangpetch and Ueasangkomsate, 2023).

This means every thing has several uses. Companies should encourage recycling to avoid waste. The circular economy saves money and resources by recycling, remanufacturing, and reusing materials and goods, according to Korhonen et al. (2018). This article discusses data analytics' importance in developing nations' circular economy.

Modern companies and organisations create enormous volumes of data, which need for sophisticated ways to analyse. Statistics help companies make data-driven decisions by organising, summarising, and interpreting data. 21st-century enterprises, organisations, and people generate more data than ever. Due to rapid technological advancement and growing data, companies must make data-driven choices (Mohammadiyeh, & Purhasani, 2023).

Data analytics is used to analyse the enormous volumes of data created in the contemporary day using advanced methodologies. Analysing and converting unstructured data into information that is relevant and helpful so that choices may be made with confidence is known as data analytics. Data analytics helps businesses and organisations understand customers, be acquainted with the trend in fashion, understand competitors, as well as in making informed decisions to grow and improve. Data analysis must be rigorous and structured to provide meaningful insights. This requires statistical data analysis. The aim of this study

therefore is to investigate how by data analytical measures, developing countries will be able to achieve sustainable circular economy.

This is imperative because, developing countries are currently facing challenges in achieving sustainable circular economy. This report embodies the concepts and benefits of circular economy, the challenges in implementing circular economy in developing countries, as well as the role of data analytical impact on achieving sustainable circular economy.

Circular Economy: Conceptual overview

The question of whether waste formation is an inevitable byproduct of our manufacturing method informs our discussion of the circular economy. Aiming for the responsible use of resources, materials, products, and the environment, alternative strategies include resource efficiency, the circular economy, closed-cycle, zero waste, reuse, waste avoidance, and recycling (Wilts, 2017). Despite its increasing popularity, a "world without waste" need an all-encompassing strategy. Environmentally responsible design is ensured from the beginning to the end by taking into account the reduction, reuse, and recycling of energy and materials throughout the course of a product's life cycle (Korra, 2022). There are several currents and iterations of the circular economy, each with its own principles, methods, and application areas. The circular economy, cradle-to-cradle, blue economy, and zero waste viewpoints of the Ellen MacArthur Foundation diverge when it comes to bio-based cycles (Patwa et al., 2021).

Significant difficulties have not been addressed in the circular economy discussion. Since ending material cycles entails inescapable losses and violates thermodynamics, it is unlikely. Any waste recycling requires energy. Unlimited circulation of fundamental raw materials would contradict climate goals even if they are not needed for extraction and processing (Korra, 2021). The circular economy will not remove the need to limit natural resource use for sustainable development. Raw material availability is another factor. Before recently, resources were discussed in terms of raw materials for commodities and processes, notably in green technologies like fuel cells and solar power.

These compounds have no appropriate alternatives, and their supply is in jeopardy because of a narrow static range, a few nations abusing their monopoly, or demand that exceeds supply. One well cited example is that rare earths are necessary to make any modern smartphone. Even a closed cycle is inadequate for industrial supply due to the rapidly increasing demand (Korra, & Valaboju, 2024). These reflections show that there are still conceptual problems with the circular economy that need more research.

Benefits of circular economy in developing economy

Developing countries adopting the circular economy face many possibilities and risks. Wilts (2017) divided the advantages of the circular economy into four groups: the economy, the environment, the utilisation of resources, and social benefits like the creation of new employment. Even with little resources, these regions may support innovative cyclical activity. In the first stance, the idea of rethinking garbage management is common in developing countries. By recycling trash, circular thinking may reduce environmental damage and enhance economic growth (Jones & Abdullah-Olamide, 2024).

Decreased demand for basic raw materials may help reduce dependency on imports. This is because it will open the door for new technologies and business models in many different sectors to create more value from our limited natural resources. Over time, this might increase the industrial sectors of emerging nations' resilience to shocks from the outside world and increase their competitiveness.

Communities should be educated in schools about circularity's benefits and real-world applications. Budget limits and weak infrastructure need creativity. Governments, businesses, and NGOs may influence legislation and gain money by cooperating. Digital technologies may help supply networks optimise resources (Jones & Abdullah-Olamide, 2024).

Waste becomes money in the circular economy, promoting fair development via sustainability. This will help poor countries flourish.

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Challenges in implementing Circular economy in developing countries

The adoption of a sustainable circular economy faces several challenges in developing nations. An economic barrier is a lack of funding to achieve circular economy needs. Food or material wastes need to be treated and repurposed, which requires R&D and infrastructure investment (Ormazabal et al., 2018). Determining if existing technology is viable enough to support this kind of transformation and assessing it will cost a lot of money. Food waste has to be transformed into high-value products at every stage of the supply chain, which is difficult, in order to justify such costs (Jaeger and Upadhyay, 2020; Masi et al., 2018).

Other economic problems include investment costs and absence of economic benefits. Circular economy business models are novel (Xia & Ruan, 2020). In the supply chain position, an organisation finds it difficult to adopt it for financial benefits. Adoption of the circular economy involves costly new business models, repurposed resources, and unpredictability in terms of finances (Clark et al., 2019; Dossa, 2020).

Information and technology challenges exist outside of economics. Sharma et al. (2019) say rising countries lack technical innovation. Food waste from the food business hurts the environment and economy. These losses might be halted by technological improvements such as biorefinery, industrial symbiosis, and eco-innovation (Clark et al., 2019). The adoption of CE is hindered by the requirement for new ideas and technology.

Second, there is the issue of inadequate SC optimisation and design. The shift from LE to CE is made easier with well-planned closed-loop supply systems that reduce environmental concerns.

The competitiveness of stakeholders and the sustainability of SC are impacted by designs. Food or material waste during production and subsequent stages in the cycle can be prevented by increasing their utilisation for value-added applications.

Supply chain (SC) disruptions may occur. Hurricanes, thunderstorms, floods, and disease outbreaks interrupt SC. Significant impacts occur in communities and industries. Agricultural food supply and production interruptions may harm consumers and the food sector (Yazdani et al., 2019). Most food in impoverished nations is lost due to poor packaging and absence of a cold chain facility (Manzini and Accorsi 2013).

Institutions contribute to certain issues. Rules, regulations, and standards are lacking in most developing nations. A Circular Economy takes tremendous labour and proactive changes to laws, practices, and regulations. The Complex Policy Framework, Administrative Structure, and Lack of Effective Legal Enforcement slowed the Circular Economy transformation (Ranta et al., 2018; Sharma, 2019). Another problem facing the organisation is inaccurate food waste estimates. Food waste production is underestimated both domestically and internationally. Thus, the absence of such crucial data and analysis hinders the development of Circular Economy frameworks and policies (Corrado & Sala, 2018).

Social variables like supplier and customer ignorance hamper adoption. Consumers contribute most food waste in underdeveloped nations. Suppliers and consumers are crucial to the linear-to-circular economy shift. For SC to accept CE, they must comprehend and be aware of recycling (Farooque et al., 2019; Sharma et al., 2019). Poor customer perception, disengagement, supplier and customer support, company awareness, behaviour, teamwork, leadership, and training and skills are social issues.

Circular economy GHG emission reduction is limited. The food supply chain (FSC) faces climate change difficulties owing to increased greenhouse gas emissions and transportation and distribution issues, according to Audsley et al. (2010). FSC GHG emissions reduction demands big reforms.

Data Analytics

Data analytic also referred to as Big data analytic is an information asset that is complicated, dynamic, and has huge volume and high velocity. Improved understanding and decision-making need complex methods and technology for information processing, collecting, storing, disseminating, and management (Sangpetch and Ueasangkomsate, 2023). Big data descriptive analytic seeks to identify and characterise the things that exist within big data and their relationships; big data predictive analytic, on the other hand, focusses on trends and forecasting by identifying problems to forecast future results or occurrences using the vast data that already exists; big data prescriptive analytics, which is concerned with deterministic analysis for big data sets and finds various problems as well as the best course of action under uncertainty (Chen et al., 2022; Sun et al., 2015). Key elements of big data analytics include data gathering, model construction, and continuous observation. These may assist organisations apply big data analytics (Sangpetch and Ueasangkomsate, 2023). Previous research has explored various factors affecting big data analytics (BDA). These factors fall under these categories: Three sorts of variables affect BDA adoption:

1) Personal factors: rational thinking, openness to BDA adoption, user satisfaction;
2) Organisational factors: readiness, alignment with objectives and culture;
3) Data factors: connectivity relative to competitors, centralisation, open network mechanisms. In addition to BDA usage, these characteristics affect user satisfaction (Hung, 2021).

Big Data Analytics's Impact on the Circular Economy

According to Chauhan et al. (2022), the circular economy may make use of several new digital technologies, such as blockchain, the IoT, big data, AI, and others. Big data efficiency is essential for improving resource circulation inside businesses that use the concepts of the circular economy, which in turn improves the efficacy of business operations (Gupta et al., 2019). Furthermore, the link between resource management and stable performance in the circular economy is influenced by the supply chain that powers big data analytics (Giudice et al., 2021). As stated by Bag et al. (2021), the circular economy's potential is directly impacted by the capabilities of big data analytics. To rephrase, companies who excel in big data analytics are in a better position to control their resources and keep the circular economy going strong. As a result, internal productivity rises and the firm has a competitive advantage that will remain. Big data affects circular economy eco-design, investment recovery, and management systems (Cheng et al., 2021).

The role of data analytical on sustainable circular economy

Data analytics or "Big Data" analytical is a phrase that has grown in corporate lexicon in the last few years. One facet of big data is large data sets. According to Hilbert (2016), data analysis is very beneficial for decision-making. A better name for this concept may be "Big Data Analytics" or "Business Intelligence and Analytics." Data that is large, moving, and diverse and that need

specialised tools and methods for analysis is called "big data" (De Mauro et al., 2015). Analytics and business intelligence have come a long way from their infancy (Chen et al., 2012). Through the use of advanced data visualisation and maintenance methods, Big Data and Analytics provide datasets and analytical processes.

According to De Mauro et al. (2015), big data is collected in real-time from several sources and is complete, integrated, and thorough. Mobile devices, the Internet, and other web-based technologies made previously inaccessible data and information available, accelerating BDA growth in the 2000s. Two characteristics characterise large data. Hilbert (2016) states that data volume determines analysis. Second, data mining and machine learning may find correlations and patterns without theory (Hilbert, 2016).

BDA allows fresh data collection and analysis, opening up new perspectives. Complex economic decisions like CE will benefit from thorough examination. BDA improves the effectiveness and sustainability of Circular Economy. Big data's quantity and accuracy promote circular economy adoption (Jabbour et al., 2017). Assessing and strengthening the company's strengths and weaknesses is vital. Before embracing circular economy, organisations should assess their situation. We handle logistics, production, and financing. Even understanding the existing reality, businesses foresee operational challenges from CE paradigm shifts. Business operations are ambiguous and imprecise, making this method unsustainable. Big data analytics can reduce uncertainty and forecast outcomes to help organisations make better decisions.

Decision-making is also made easier using BDA. The circular economy idea of sharing resources and integrating processes may find answers in big data. From the studies reviewed in the course of this report, (Cheng et al., 2021), it is a general consensus that individuals may benefit from using prediction models that use both past and present data when making choices. Data-driven decisions lead to sustainable business practices, while industry-specific differences exist in the use of strategic data decisions. As mentioned in the barriers, operational complexity may make it difficult for businesses to implement a CE paradigm. Data analytical practices may be utilised to create process-level interventions and examine operational details. Thus, by figuring out supply side variations and consumption trends might assist solve operational issues. Both short- and long-term critical constraints will be recognised. Think about rethinking business operations in a cyclic rather than a linear fashion by using data from various domains. As elicited from the materials studied, big data might have a beneficial impact on decision-making on labour performance, raw material availability, health, safety, and the environment, as well as production and maintenance unpredictability. When it comes to solving operational problems and developing decision-making models, BDA has emerged as a crucial instrument.

CONCLUSIONS AND RECOMMENDATIONS

To manage the shift towards the Circular Economy paradigm, it is imperative to adopt a comprehensive systems approach that incorporates all available research data. The concept of systems thinking is widely acknowledged by scholars and business executives. Several studies indicate that businesses are a component of a larger ecosystem that includes a variety of stakeholders (Hester and Adams, 2014). The systems approach to creating circular economies has been the subject of several studies (Murray et al., 2017). A systems thinking approach, which emphasises the whole above the individual, is consistent with the CE paradigm.

Since current corporate practices are predicated on the notion of working autonomously, they often ignore this kind of job. Every business in a supply chain transfers and transforms goods, services, and data from the beginning to the end, which is the customers.Coordination difficulties between supply chain players' activities may arise. Conflict sometimes arises from differences in members' goals, expertise, and views on events that affect collective decision-making (Stern & Heskett, 1969). Besides these factors, management sluggishness caused by imprecise rules for emerging supply chain collaboration may cause conflict (Simatupang and Sridharan, 2002). Since managers are taught to focus on individual tasks, they may not comprehend synchronised operations. When acting as autonomous companies, supply chain participants may set rules for demand forecasts, stocks, logistics, and finance without considering other stakeholders. Cost inefficiencies, poor customer service, and supply chain profitability may diminish.

Unfortunately, CE-based business methods have comparable issues. Since no one business can manage all CE adoption aspects, all organisations should be proactive about disputes. We emphasise that a systems view allows stakeholders to work together towards common goals (Despeisse et al., 2017). Individual firms may build trust faster with this mentality.

Trust and devotion are needed to exchange information and understand organisational actions. Mutual trust allows crucial information to be communicated. The huge volume of available data requires BDA to uncover significant patterns. Considering data from several CE members may be useful. This data may inform production and consumption decisions at all model levels. According to Freeman's (1994) collaborative stakeholder theory, CE model members' relationship interactions determine operational coordination and collaboration.

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