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# BUSINESS INNOVATION AND QUANTITATIVE MODELS IN CIRCULAR ECONOMY AND CLOSED LOOP SUPPLY CHAINS/REVERSE LOGISTICS: A SYSTEMATIC REVIEW OF LITERATURE

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**Abstract**
*Circular Economy makes an effort to overcome "take-make-waste" pattern of production and proposes a system in which value of products, services and resources is maintained in the system. It helps organizations to synergize their value systems for economic, social and environmental gains. Closed Loop Supply Chains (CLSC) can serve as a mean towards creating value in circular economy. Eminent scholars have contributed to the literature of CLSC focusing on key business decisions like product remanufacturing, inventory and demand management etc. Through a SLR, this paper aims to highlight the importance of different business and quantitative models that have been developed and have informed firms' decision making in CE and CLSC. Our analyses suggest that conceptual models have been developed in much extent in CE and now there is a need to yield results by deploying these models through CLSC.*

**Keywords**: *Strategic Human Resource, Employee perception of HR practices, Theoretical perspective*

## Introduction

The increased attention towards closed loop supply chains (CLSC) emerged from government legislation initially, as concerns of environment sustainability have gained importance. Owing to the fact that public awareness has grown (Dowlatshahi, 2000), firms are focusing more on closed loop supply chain and reverse logistics. There has much attention towards reduction of material and resource intensity in production process, product lines and wastage (Daaboul et al., 2016; Genovese et al., 2017). In forward the supply chains and flow of material is uni-directional i.e., from supplier to manufacturer to distributor to retailer and to end consumer. In closed supply chains, there exist reverse flows of products. Reverse logistics (RL) is considered as one part of CLSC in which the key focus is on reverse flow of product over the supply chain (Tonanont et al., 2008). RL/CLSC is seen as an opportunity by the firms to increase revenue (Guide Jr & Van Wassenhove, 2009) thus firms are concerned about various operations decisions in CLSC like product remanufacturing, inventory and production planning, price and technology, demand scheduling and network design (Dev et al., 2017; Genc & De Giovanni, 2017; Hasani et al., 2012; Hatefi & Jolai, 2014; Roghanian & Pazhoheshfar, 2014; Savaskan et al., 2004).

In 2009, Guide Jr. and Van Wassenhove provided a definition of Closed-Loop Supply Chain (CLSC) as the strategic management of systems aiming to optimize value generation throughout a product's entire lifecycle, encompassing its design, control, and operational aspects. This involves the dynamic reclamation of value from diverse types and quantities of returns over the course of time. Running alongside CLSC, the concept of a circular economy (CE) has garnered considerable scholarly interest as evidenced by contemporary studies (N. M. Bocken et al., 2016; Ghisellini et al., 2016). The particular definition of a circular economy adopted in this paper denotes an industrial framework intentionally designed for restoration. This framework prioritizes the facilitation of efficient material, energy, labor, and information

flows, with the overarching aim of rejuvenating both natural and social capital. CLSC and CE both incorporate the same concept of developing sustainable economic, social and environmental value. According to Guide Jr and Van Wassenhove (2009), CLSC has three major activities that are driven by cost minimization (Govindan et al., 2015) rather than value creation (Abdallah et al., 2012) which is more of a concern in reverse logistics.

Business models have been explored insightfully under closed loop supply chains and circular economies separately, but there is a gap in research that integrates the strides of both towards determining possible prospects for future research. This article tries to review and summarize different business innovation and quantitative models under the two umbrellas (CLSC and CE) and put forward possible implications for convergence of the two streams.

The flow of the article is as follows. We first give a brief review of literature of different business models that have been studied in CLSC and CE. Next, we discuss the extent to which business models have grown in these domains, based on a systematic review of literature in this field. We also come up with future research directions in business models in the field of CLSC and CE based on a holistic comparison and contrast of various models used in these domains. The study will add into body of knowledge based on the case it builds for the researchers to use different business models to add into body of knowledge in the field of CLSC and CE.

**Literature Review**

Switching from linear economic models to circular ones allow organizations to bring hundred million in saving and also reduce negative impact on the environment (EMF, 2013; Forum, 2014). Increased interest of organizations towards sustainability has also allowed researchers to explore circular economy. Circular economy is considered to be the most rigorous move towards sustainability (Scott, 2017). To implement circular economy on micro-level, it is required by organizations to develop comprehensive knowledge in CE business models. There are several tools, techniques and frameworks available in existing literature that allow development of business models (Bernd, 2011; Osterwalder & Pigneur, 2010).

Circular Economy: The world around us is majorly non-sustainable focusing on “Take-make- waste” process that is based on linear economic model. The traditional business models have focused on optimizing business outcomes, ignoring the adverse effects created on the environment. Contemporary businesses are now focusing on an industrial system where the focus has shifted on reiterative and regenerative processes that preserve, even upgrade, the value creation in the business. This is achieved by active involvement and interaction of key actors (stakeholders) (Antikainen & Valkokari, 2016). Circular economy, that involves a closed loop that consists of two supply chains (forward and reverse), is an evolving concept and there exists a gap in consolidation of its definitions, boundaries, key concepts and principles and associated practices (Merli et al., 2018). Merli et al. (2018) conducted an extensive literature review within the realm of CE, underscoring three primary avenues of emphasis within CE research. These include, firstly, the alteration of broader societal and economic dynamics on a macroscopic scale. Secondly, there is a concerted effort to assist enterprises in the adoption of circular practices, thereby fostering inventive product designs that mitigate waste and enhance reutilization. Lastly, attention is directed towards the cultivation of industrial synergies. There are different studies that have conducted a comprehensive review and analyses of various underlying concepts, themes, tools and techniques, sustainability issues, green-bio economy relationships and product-service reusability (D'Amato et al., 2017; Geissdoerfer et al., 2017; Lewandowski, 2016; Winans et al., 2017). Winans et al. (2017) suggested that central theme of CE revolves around valuation of materials within a closed loop supply chain where the key focus is resource sustainability and economic growth. A

complete body of literature has been devoted towards development of business models in circular economy (Lewandowski, 2016).

Different authors (EMF, 2013; Joustra et al., 2013; Mentink, 2014; Scott, 2017) have focused on definitions of circular economy business models. Others (Barquet et al., 2013; Bernd, 2011; Jabłoński, 2015; Osterwalder & Pigneur, 2010) highlighted conceptual models developed in circular economy.
Reverse logistics, also known as closed loop supply chain (CLSC), is a response to the limitations of traditional forward supply chains, which often do not account for end-of-life (EOL) products. This approach, highlighted by Govindan & Soleimani (2017), focuses on enhancing environmental sustainability by managing these EOL products. Souza (2013) categorizes the challenges in CLSC into three levels: strategic, tactical, and operational. Strategic issues encompass product remanufacturing by original equipment manufacturers (OEMs), product takeback options like leasing or trade-ins, and coordination across the supply chain. The tactical level involves developing acquisition and disposition models, either single or multi-period. Operational concerns include disassembly planning, scheduling, setting priority rules, lot sizing, and routing.

Over the past two decades, CLSC research has primarily concentrated on remanufacturing, waste management, and recycling, as per Govindan & Soleimani (2017). CLSC serves a dual purpose: firstly, it adds value to processes to meet customer demands, and secondly, it retrieves EOL products from customers to determine the most effective utilization methods. This concept is depicted in Figure 1, illustrating both the forward supply chain processes (supplying raw material, assembling, processing, distributing/retailing, and consumption) and the reverse supply chain activities (reconditioning, repairing, disposing, and recycling).

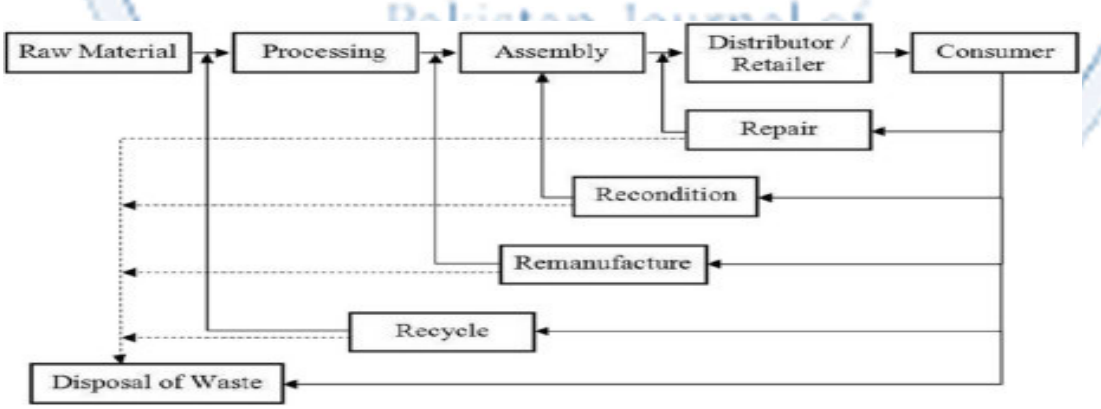

Figure 1 (Khor & Udin, 2012)

**Closed Loop Supply Chain as a mean towards Circular Economy:**
CLSC becomes a mean towards circular business models that is a solution for circular economy that led to a phenomenon of circular business models (Geissdoerfer et al., 2017). Figure II gives a comprehensive

explanation of the role of closed loop supply chain towards development of circular economy that ultimately result in circular business model.


Figure II (Geissdoerfer et al., 2017)

Circular business models, as identified by N. Bocken et al. (2013), are key outcomes of sustainable supply chains within the broader framework of the circular economy, functioning as strategies for sustainable business practices. These models aim to enhance supply chain sustainability by minimizing waste and emissions through dematerialization and by slowing or narrowing resource loops, as discussed by N. M. Bocken et al. (2016). Geissdoerfer et al. (2017) further explain that circular business models operate at various levels of economic, environmental, and social sustainability, each offering unique approaches to value proposition, creation, delivery, and capture.

**Methodology:**

Conducting a systematic literature review ensures the utmost rigor and replicability in research methodology. Originally devised in the medical field to effectively assimilate vast volumes of information and provide foundational data for informed decision-making (Mulrow, 1994), systematic reviews have evolved into a transparent methodology employed to locate, assess, and amalgamate existing studies within a specific research domain, thereby yielding fresh insights into phenomena (Petticrew, 2001). This technique, introduced to the realm of management and organizational studies by Tranfield et al. (2003), has gained significant popularity for synthesizing a diverse array of evidence to offer valuable insights. To address the necessity outlined in the introduction, a scoping study was initially conducted. Following the guidelines set forth by Tranfield et al. (2003) and Denyer and Tranfield (2009), a review protocol was established, encompassing research questions, literature search strategies, and inclusion and exclusion criteria. Denyer and Tranfield (2009) provided a five step process for systematic literature review: "(1) Locating studies, (2) question formulation, (3) analysis (4) and Study selection/evaluation (5) reporting results."

**Question Formulation:**

The key question formulated for this SR was "What modeling techniques and frameworks have been focused in the field of CLSC and CE over the last ten years?"

**Locating studies:**
To build on the previous literature reviews in the field of closed loop supply chains (Govindan et al., 2015) and circular economy (Merli et al., 2018) and identify contemporary research, we focused business models in CLSC and CE in a time span of ten years i.e., 2008-2018. We were interested in studies that relate to develop overlapping understanding towards business models development in CLSC and CE. We included six journals in our search (table I). We used four strings of keywords to locate studies in the field of operations and supply chain management as mentioned in table 2.

**Table 1**

| **Journals Included in the literature review** |
|---|
| "International Journal of Production Economics" |
| "International Journal of Production Research" |
| "Journal of Cleaner Production" |
| "Transportation Research: Part" |
| "Computers and Industrial Engineering" |
| "European Journal of Operational Research" |

We used EbscoHost electronic database to facilitate our search. The search included only peer reviewed articles published in mentioned journals through this database. The criteria for selecting these journals are threefold: Firstly, the journals we used are well represented in previous literature reviews on Closed Loop Supply Chains and Circular Economy. Secondly, the journals welcome almost all dimensions of research methods used in the CLSC and CE. Thirdly, the journals are categorized as "A" or "A*" in the rankings published by Australian Business Deans' List (ABDC) (www.abdc.edu.au/master-journal-list.php).

| ***String No.*** | ***Keywords*** |
|---|---|
| *String 1* | *"Business Models in Circular Economy"* |
| *String 2* | *"Closed Loop Supply Chain Models"* |
| *String 3* | *"Closed Loop Supply Chains and Circular Economy"* |
| *String 4* | *"Business Models in Closed Loop Supply Chains"* |

**Study Selection / Evaluation:** These keywords returned a total of 450 articles. We restricted the search to peer reviewed, full text articles. The articles were screened for relevance and duplication and a subset of 230 articles was drawn. Reviewing these articles would require a comprehensive approach so we further narrowed down the number of articles for review purpose to 77 by using random sampling technique (Berenson et al., 2012).

**Analysis / Synthesis:** In our analysis, we use different ways to synthesize the screened studies. We evaluate the studies in CLSC and CE using a modeling framework devised by Beamon (1998) who categorizes supply chain design and analysis into four types of models (1) Deterministic analytical (2) Stochastic analytical (3) Economic models and (4) Simulation models. Further, there are other modeling techniques being used in the literature as mixed integer, game theoretical and fuzzy sets. We categorize the selected studies on the basis of modeling techniques being used to identify the key techniques used in CLSC and CE literature.

| | Closed Loop Supply Chain | Circular Economy |
|---|---|---|
| Conceptual Models | 2 | 20 |
| Game Theoretical Models | 4 | 2 |
| Analytical Models | 5 | 2 |
| Dynamic Equilibrium Models | 2 | -- |
| Mixed Integer | 13 | -- |
| Deterministic | 13 | -- |
| Simulation | 4 | -- |
| Mathematical Programming | 3 | -- |
| Stochastic | 2 | -- |
| Total | **48** | **24** |

Table 3

Table 3 reveals that majority of conceptual models have been developed in Circular economy. As discussed above, circular economy is a broader concept and CLSC is used as a mean towards Circular Economy. Similarly, various quantitative techniques have been developed in CLSC focusing on product remanufacturing, inventory management, network design, price and technology decisions and demand uncertainty (Akçalı & Cetinkaya, 2011).

**Conceptual Models:**

The Circular Economy is primarily driven by the 3R model: reduce, reuse, and recycle. Ranta et al. (2018) conducted a multiple case study integrating the 3R model with business strategies, examining the viability of various business models across industries in China, the US, and Europe. Urbinati et al. (2017) introduced a taxonomy of Circular Economy Business Models, categorizing them based on customer value interface and value network. The Circular Economy's focus on value creation often leverages Closed Loop Supply Chains (CLSC) as a mechanism for enhancing and maintaining value, as highlighted by Mishra et al. (2018).

In the service sector, particularly in information and communication technologies, Heyes et al. (2018) explored the development and application of circular economy business models. Their model, rooted in Backcasting and Eco-Design principles, serves as a resource for uncovering Circular Economy opportunities within service industries. Furthermore, conceptual models in the Circular Economy have proven effective for environmental value propositions. Manninen et al. (2018) evaluated an environmental value proposition framework across various business models, finding that environmental benefits can be achieved through their strategic implementation.

**Game Theoretical and Analytical Models:**

Our review indicates a strong preference for game theoretical and analytical models in closed loop supply chain (CLSC) research, particularly in analyzing second-hand markets and life cycle assessments in the

circular economy. Analytical models, like those by van Loon et al. (2018), have shown that second-hand markets in linear systems outperform those in CLSCs, primarily due to higher consumer preference for new products. Scheepens et al. (2016) further this insight by demonstrating how a life cycle assessment-based model can lead to sustainable business practices that positively impact the environment.

On pricing strategies within CLSCs, Esmaeili et al. (2016) adopted game theoretical approaches to consider factors like manufacturing rates and government subsidies. Yoo and Kim (2016) delved into the pricing dynamics within a three-tier supply chain, revealing different structures for new and refurbished products. Similarly, Y. Huang and Wang (2017) explored optimal remanufacturing approaches in a three-echelon supply chain, underscoring the complexity and potential of hybrid closed loop supply chains.

**Simulation / Deterministic and Mixed Integer Models:**
In the field of closed loop supply chains (CLSC), deterministic and mixed integer programming models are the most prevalent modeling techniques. The existing body of research has extensively applied these models to a variety of business decisions. This includes applications in inventory management, robust optimization to tackle demand uncertainty, time delays, variations in system cost parameters, and disruptions in customer demand. Additionally, these models have been used for designing supply chain networks, taking into account various uncertainties and cost structures. Key studies in this area include research by Chuang et al. (2014), Hamidieh & Fazli-Khalaf (2017), X.-Y. Huang et al. (2009), Kim et al. (2018), and Yuan et al. (2015).

Mixed Integer Programming (MIP) models have seen extensive application in closed loop supply chains, addressing a variety of decision-making aspects. These include location allocation and product recycling choices (Chen et al., 2015), strategies for reclaiming End-of-Life (EOL) vehicles (Shankar et al., 2018), and considerations for risk management in CLSC design (Baptista et al., 2018). MIP models have also been instrumental in optimizing flexible delivery systems within CLSCs (Behmanesh & Pannek, 2016). Furthermore, the application of these models has expanded into the realm of green supply chains, particularly for selecting environmentally sustainable suppliers and disassembling products (Ghayebloo et al., 2015). A concise overview of various decision variables associated with different modeling techniques is presented in Table 4.

| Closed Loop Supply Chains/Reverse Logistics Models | | | |
|---|---|---|---|
| | Stochastic / mixed integer | Deterministic | Game Theoretical / Simulation |
| Product Remanufacturing | Ghayebloo et al. (2015) | Bazan et al. (2017)<br>Y. Huang and Wang (2017) | Lehr et al. (2013) |
| Inventory Management | | Yuan et al. (2015) | Patne et al. (2018) |
| Network Design | Vahdani and Mohammadi (2015)<br>Hasani et al. (2012)<br>Torabi et al. (2016) | Hamidieh and Fazli-Khalaf (2017)<br>Jena et al. (2018) | |
| Price and Technology | | | Esmaeili et al. (2016) Yoo |

| | | |
|---|---|---|
| Decisions | | and Kim (2016) |
| Demand Scheduling in uncertainty | Kim et al. (2018) | X.-Y. Huang et al. (2009) |

Table 4

**Discussion and Future Direction:**

Scholars have approached CE from various dimensions like socio-economic dynamics, process implementation and industrial convergence (Merli et al., 2018). In our review of literature, we identified that CE has a major role to play at macro level, focusing on the change at administrative level. On the other hand, studies on CLSC have majorly focused on tactical decisions using quantitative models. Our review of recent studies in the domain of CLSC and CE suggest that there is enough room for researchers to publish in CLSC and CE focusing on environmental sustainability. Journal of cleaner production has shown the maximum number of research articles published in the area of circular economy and closed loop supply chain over the last ten years. Conceptual models and frameworks have been given much attention in CE as compared to CLSC. Circular economy has been approached as a broader phenomenon to help organizations, create more value. Circular business models have gained much importance for the last few years. There is a need to implement these models in real time through tools and techniques available so that firms in different industries can reap the benefits of CE through CLSC.

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