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Collaborative closed-loop supply chain framework for sustainable manufacturing: Evidence from the Indian packaging industry

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ABSTRACT

Businesses reeling from the impact of COVID are struggling to achieve sustainability, amidst many other challenges, including finance and capacity shortfalls. One of the pathways to achieving 3BL in businesses is to create closed-loop supply chains (CLSC) covering the entire lifecycle of products. CLSC have proven to be important for sustainable supply chain (SC) operations, given the shortage of materials and labour globally following the COVID-19 pandemic. While it is widely acknowledged that the success of CLSC depends on successful collaboration between SC members, factors for successful CLSC collaboration are not sufficiently understood from the literature. Employing an observation-based case study and a survey of SC members, we develop our contribution in the context of an Indian packaging company, to delineate and verify a collaborative CLSC framework. The results confirm that the success of CLSC collaboration lies in the involvement and commitment of SC members. Collaboration for *forward* and *reverse* SC operations also facilitate the involvement of SC members in CLSC collaborations. Our research suggests that SC collaborations are enhanced by explicit incentive-sharing schemes and having the same SC members for both forward and reverse SC operations.

1. Introduction

Meeting the requirement of sustainable operations is a big challenge for every supply chain (SC), as governments around the world redirect their attention to encouraging the triple-bottom-line (3BL) approach to promote SC sustainability integrating social, economic, and environmental objectives simultaneously (Ramanathan et al., 2014, 2017). One of the pathways to achieving 3BL in businesses, which has attracted increasing attention from practitioners and researchers, is the creation of closed-loop supply chains (CLSC). Simonetto et al. (2022) reviewed the existing literature on CLSC and suggested that CLSC generally covers the entire lifecycle of products, integrating normal forward SC processes from raw materials to customers with reverse SC processes, covering recycling, reusing, repairing, remanufacturing, and disposal triggered by faulty products, product returns, or end-of-life product disposal. More recent researchers have started to include the economic value of recycled materials within the CLSC in the context of the circular economy (Colucci and Vecchi, 2021; Lotfi et al., 2022). For example, Ramanathan et al. (2017) provided evidence that some pharmaceutical companies are actively involved in closed-loop manufacturing by recycling and reusing herbal residues in the manufacturing process or in generating by-products. These practices contribute to the 3BL goals by reducing waste and dumping, while generating additional business and social values. Moreover, Mercedes Benz is using recycled and sustainable materials (such as recycled PET bottles) to produce upholstery fabric for its car interiors. This kind of value creation activity supports the 3BLs of economic, environment and social aspects of the company and demonstrates the potential of CLSC operations (OEM, 2022).

Previous studies have argued that the reverse SC processes have become commonplace due to consumer rights, providing opportunities for customers to return products within a limited period after purchase. Hence, reverse SC processes have also come to dominate the discourse on SC management for reasons such as defective products, improper information, wrong product, wrong address, commercial returns, end-

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of-lease-period returns, repair/warranty returns, and end-of-life product returns (Guide and Van Wassenhove, 2001; Reim et al., 2021; Shaharudin et al., 2015; Toktay et al., 2000). Each of these types of reverse SC processes needs to be handled in a distinct way to attain maximum benefits, to avoid loss, or to meet regulatory requirements. Because of the complexity of the processes, many firms necessitate close collaboration with SC members in order to streamline reverse SC processes. For example, in the case of end-of-life returns of electrical and electronic equipment (EEE), the treatment of returned products involves hidden operations that need to follow local government environmental policies. EEE manufacturers have to seek support from other SC members to minimise the cost associated with this operation. Depending on the quality and conditions of product returns, the disposal of commercial returns needs different levels of support from SC members (Guide and Van Wassenhove, 2001).

However, since SC members usually operate at different stages of the SC and have independent performance goals, factors like supply uncertainty, testing and sorting, and interrelations between forward and reverse operations make the reverse SC a very complicated task (Fleischmann et al., 2004). Indeed, effective reverse SC operations need collaborative involvement and support from other SC members (Beh et al., 2016). SC collaboration has been especially important during the COVID-19 pandemic, because many businesses have been struggling to maintain the balance between financial performance, SC disruptions, and expectations of sustainable business operations (Sharma et al., 2020). Therefore, closer collaborations between SC members are called for to ensure that all 3BL goals can be met (Ramanathan et al., 2021a).

CLSC originated from reverse logistics planning, and has been defined from various perspectives (e.g., Beh et al., 2016; Govindan et al., 2015; Tunn et al., 2021). The seminal study of Guide and Van Wassenhove (2009) defines CLSC as the design, control, and operation of a system to maximise value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time. Hence, based on the existing CLSC literature and practices, we define CLSC as the collaborative efforts of SC members to capture value in each SC process (forward and reverse) by value addition through recycling, reusing, and remanufacturing while maintaining environmental sustainability.

Nevertheless, the extant literature suggests that the concept of CLSC and SC collaboration have been studied mainly for retail and wholesale SCs but have not been widely adopted in the traditional manufacturing sector. The manufacturing sector is known for its significant environmental impact, but also for its potential to achieve further development in terms of 3BL through effective collaborations (He et al., 2019). While several authors have discussed end-of-life product returns and warranty/repair for retail SCs (Guide and Van Wassenhove, 2001; Reim et al., 2021; Shaharudin et al., 2015; Toktay et al., 2000), there is limited specific literature on the benefit of collaboration around CLSC for manufacturers, and hence no practical guidance for manufacturers to enhance CLSC. Therefore, we have considered this topic specifically to analyse how collaboration among SC members will help manufacturers who use returned products to remanufacture or upcycle.

In this study, we investigate the collaborative relationship among SC members in forward and reverse SC operations as part of the CLSC, aiming to improve business performance and to create win-win situations. In doing this, we also explore the impact of the Covid-19 pandemic on collaborative relationships during firms' CLSC operations. Employing an observation-based case study and a survey of SC members, we develop our contribution in the context of an Indian packaging company. Our objective is to identify and provide insights into the factors essential to create resilience to enable companies to maintain their level of sustainability.

We delineate and verify a collaborative CLSC framework that focuses on the determinant factors that may facilitate (or impede) the success of SC collaborations in CLSC operations by carrying out a three-stage empirical study. In stage 1, we develop a collaborative CLSC framework and its related research hypotheses. In stage 2, we conduct a case study of an Indian package manufacturing company covering the period from 2011 to 2020. In stage 3, we collect data using a questionnaire survey to test the hypotheses. Our research will contribute to the CLSC literature by suggesting the best options for SC collaborations in achieving CLSC performance objectives and by further extending the application of RBV into the area of CLSC collaboration. Our results will also provide important guidelines for practitioners, especially in the traditional manufacturing sector, to enable them to form more effective SC collaborations to implement CLSC strategies.

The remainder of the paper is structured as follows. Evidence from the literature is outlined in Section 2 to explain the background of this study. In Section 3, a collaborative CLSC framework and research hypotheses are developed. Section 4 focuses on the SC collaboration through a case study of a package manufacturing company. Section 5 illustrates the survey and model testing. Section 6 discusses the main findings of this study. Finally, Section 7 concludes with possible future research directions.

2. Research background and literature

Although it is possible that values can be retained through the disposal of returned products through either mainstream or secondary markets (e.g., in the garment retail industry), in many sectors returned products will be considered simply as waste, which incurs costs in handling and processing (Beh et al., 2016; Lingaitiene et al., 2022). In order to maximise profit, effective handling and disposal of returned products before their value erodes is crucial and highly challenging for businesses. This task requires a high level of collaboration and effective coordination among firms in the supply network to support planning, logistics, quick handling, processing, and reselling of returned products (Beh et al., 2016; Mahadevan, 2019; Ramanathan et al., 2021b). Such effort is evident from cases like Wal-Mart and P&G, which actively participate in collaboration with SC partners for effective handling of product returns (Ireland and Crum, 2005).

Traditionally, the main objective of SC collaboration is to bring SC players, including suppliers, manufacturers, and wholesalers/retailers, together to provide better products and services to buyers at lower costs (VICS, 2002). According to the Resource-Based View of the firm (RBV) there are two preconditions for competitive advantage (Barney, 1991): resource heterogeneity and imperfect mobility. Resource heterogeneity requires that not all firms possess the same amounts and kinds of resources; imperfect mobility entails resources that are non-tradable or less valuable to users other than the firm that owns them (Peteraf, 1993). It is due to these preconditions that collaborative inter-firm relationships will generate potential mutual benefits, which allow the sharing of complementary resources between partners while maintaining independent status (He et al., 2020). For example, resource sharing between SC members is evident in the form of third-party logistics (3PLs), shared truck spaces, and shared warehouse facilities. These approaches ensure that the cost of operations is shared among all players and hence the cost of each transaction is kept low.

Nevertheless, environmental regulations and stakeholder pressures bring SC members together to collaboratively adopt the best operational programmes to reduce environmental impacts (Ramanathan et al., 2014, 2017). For example, some SCs use resource sharing as a strategy to reduce waste, while others use incentive sharing as a tool to encourage collaborating members to take part in new, cleaner operational initiatives.

Reverse SC has also come to dominate the discourse on modern SC management due to regulations, stakeholder influences, and requirements to retain the value of businesses. Nowadays, it is of important business interest that every returned product is sold, recycled, or remanufactured before its value erodes. For example, the German supermarket chain Aldi manages its customer product returns within its stores by reselling products in the same packaging or repacked to sell at a reduced price. This is one of the best examples of '*supply chain design for sustainability*', similar to the method started by Hewlett Packard (Preston, 2001). Eventually, handling of reverse SC operations needs the attention of the whole SC in order to improve the overall operational performance (Dowlatshahi, 2000). To achieve good operational performance in reverse SCs, internal commitment of all SC members is the main driver, but uncertainty in the reverse flow of products is the foremost constraint (Carter et al., 1998). While this uncertainty is unavoidable, the process could potentially be better managed through collaborative efforts of SC members.

Although forward SC and reverse SC share some commonalities in terms of the flow of materials and information, interfirm collaboration in reverse SC operations is fundamentally different from that in forward SC operations. At the strategic level, formation of effective collaborations can be a significant challenge for the CLSC strategy, because there are various reasons for reverse SC (e.g., end-of-life, faulty product return, remanufacturing) and the chances of product reselling and value regeneration may determine the actual involvement of each SC member (Simonetto et al., 2022). Moreover, the knowledge and policies regarding reverse SCs can be very different between SC members (Waqas et al., 2018). Hence, shared understanding between SC members can be much more difficult to achieve. At the operational level, in reverse SCs it is much harder to identify responsibilities and roles of SC members, as the boundaries of reverse SC operations are more blurred than in forward SC operations (Wilson and Goffnett, 2022). Hence, reverse SC can be much harder to manage and to achieve operational efficiency. For these reasons, interfirm collaborations in reverse SCs can become hugely complex.

As such, the concept of SC collaboration in reverse SC operations is still emerging in the recent two decades (e.g., Bai and Sarkis, 2013; Beh et al., 2016; de Paula et al., 2019; Fuente et al., 2008; Mahadevan, 2019; Wilson and Goffnett, 2022). Hence, there is limited understanding of whether RBV will apply to the context of interfirm collaboration in reverse SC operations in the same way as in forward SC operations. The integration of reverse SC operations with forward SC operations is also rarely discussed in the literature (e.g., Beh et al., 2016; Waqas et al., 2018). One possible reason for this could be the lack of a strong, substantive theoretical underpinning for reverse SC operations (Carter et al., 1998), which has called for many academicians to work on the construction of such an underpinning with a more holistic view of practical applicability (e.g., Carter et al., 1998; Dowlatshahi, 2000).

To this end, some previous studies attempted to clarify the role of reverse logistics and the impact of governmental pressures on the performance of manufacturing sectors (e.g., Abdulrahman et al., 2014; Lai et al., 2013; Ramanathan et al., 2017). For example, Ramanathan et al. (2017) argued for the importance of environmental regulations as the primary influencing factor on the environmental practices of any business firm. Other researchers (e.g., Fuente et al., 2008) tried to integrate forward and reverse SC operations to redefine companies' management procedures. Östlin et al. (2008) classified the relationship between SC members based on types of returns and on available remanufacturing opportunities. Two decades ago, Dowlatshahi (2000) tried to develop a theory of reverse logistics, arguing that good knowledge and the best practices on operational factors will help companies to better use reverse logistics. After two decades, this viewpoint remains almost the same (e.g., Beh et al., 2016; Ramanathan et al., 2021b).

However, in the previous literature, few empirical studies have discussed the role of SC collaboration in CLSC operations from the RBV perspective. Findings of previous studies were largely fragmented and offered limited substantive theoretical implications. Therefore, in an attempt to provide a better insight into SC collaborations in both forward and reverse SC operations, we draw on the RBV (Barney, 1991) to understand the current SC collaboration practices of an Indian package manufacturing company engaged in CLSC operations.

The sustainable practices of businesses adopting CLSC are not normally visible to the external public, partially because those practices usually happen behind the scenes, and also because of the need to avoid unnecessary knowledge spillover to competitors. Therefore, unpacking the practices of recycling and value economy prevailing in companies will unveil important hidden CLSC practices.

3. Collaborative CLSC framework and hypothesis development

According to the RBV, the competitive advantage of firms originates from the possession of inimitable resources (Barney, 1991). This view contends that some resources and capabilities can only be developed over long periods of time (i.e., path dependence). It may not always be clear how a firm can develop these capabilities in the short to medium term (i.e., causal ambiguity), and some resources and capabilities cannot be bought and sold (i.e., social complexity) (He et al., 2020). From this vein, the concept of SC collaboration recommends the involvement of SC members in all possible operations for planning, forecasting and replenishment. However, SC collaborations are well discussed in the literature on forward SC operations (e.g., Acquah et al., 2021; Baah et al., 2021), but not in the case of many reverse SC operations.

In the past, reverse SC operations were believed to be required only for products that contained recyclable materials, such as plastics, papers, and metals (Dowlatshahi, 2000). However, due to the increasing environmental concerns, wider recycling and waste disposals schemes have become the norm for almost all industries, as required by government regulations and consumer groups. For example, Agfa-Gevaert, a Belgium-Germany manufacturer of EEE, has developed recycling guidelines that require spare parts to be marked with recycling codes (Spengler and Schroter, 2003). In the UK, almost all county councils make efforts to reduce the volume of household waste generation by implementing new policies for waste disposal (Bulkeley and Gregson, 2009). In line with this, many manufacturers include recycling codes in products at the time of packaging or at the end of the manufacturing process. Apart from being environmentally friendly, reverse SC is also treated by many companies as a second chance for profitability and reclamation of assets (Beh et al., 2016; Colucci and Vecchi, 2021; Daugherty et al., 2002;) and to generate higher returns on investments (Colucci and Vecchi, 2021; Ramanathan et al., 2017).

However, the involvement in reverse SC operations by SC members is not guaranteed and can be limited due to complex processes, the potentially unequal distributions of costs and benefits between SC members, and the lack of clarity in regulations for reverse SC operations (Daugherty et al., 2002; Waqas et al., 2018). As a result, the involvement of SC members becomes a bottleneck for collaborative reverse SC operations and CLSC. In this paper, *involvement* refers to participation of SC members in collaborations for forward and reverse SC operations as parts of CLSC.

In reverse SC operations, it is very important that the value of items returned to the original seller, or to the original equipment manufacturer (OEM), should be higher than the operational costs incurred, such as shipping, processing, and customs costs (Tan et al., 2003). According to Kulp et al. (2004), the holding cost of a returned item is dependent on the physical size, perishability, and value of products. For such reasons, Olorunniwo and Li (2010) advocate that if the same players of forward SC operations are used for handling reverse SC operations, the cost of operations (e.g., sorting and logistics) will be reduced. Therefore, due to the cost reduction incentives, it could be argued that SC collaborations will lead to higher levels of involvement of SC members in both forward and reverse SC collaborations. Therefore,

Hypothesis 1. Collaboration for *forward* SC operations will be related to the level of involvement of SC members in CLSC collaborations.

Hypothesis 2. Collaboration for *reverse* SC operations will be related to the level of involvement of SC members in CLSC collaborations.

Because the purposes and reasons for reverse SC operations vary greatly, there are many uncertainties involved in forecasting the timing and quality, as well as exact quantities or volumes, of reverse flows of products (Pushpamali et al., 2021). As a result, reverse SC operations will pressurise the inventory systems of companies due to unpredictable building up of inventories.

Previous studies provided evidence that collaborative information-sharing and joint decision-making on sales and inventory in forward SC operations helps with the accurate planning and forecasting of many companies (Baah et al., 2021; Ramanathan and Muyldermans, 2010). For example, inventory information sharing and collaborative forecasting of demand between SC partners can help with future planning and replenishment (Aviv, 2007; Baah et al., 2021; Kulp et al., 2004; Ramanathan and Muyldermans, 2010). Similarly, information sharing and collaborative decision-making among SC partners in reverse SC operations can also help to increase the rate of reselling or waste reduction (Wiengarten et al., 2010), and hence have a potential positive impact on planning, production, and cost savings. For example, Marien (1998) found that if SC members collectively plan warehouse facilities and return centres, some costs of inventory, transportation and waste disposals will be reduced. Such operational improvements reinforce SC members' positive expectations and commitment to continue the collaboration in CLSC operations. In essence, it is understandable that collaborative decision-making in the form of information sharing enhances the committed participation of SC members in both forward and reverse SCs and thus in CLSC operations. This argument helps to formulate our next hypothesis:

Hypothesis 3. Collaborative decision-making will be significantly related to the commitment of SC members in CLSC collaborations.

According to Nyaga et al. (2010), SC partners' investment in collaborative activities will have a positive impact on trust and commitment between partners. In the same vein, Giannetti et al. (2013) found that 'logistics structure' is one of the most important factors in managing reverse SC in the steel manufacturing sector, so that the sharing of responsibilities and incentives will shape the performance of the reverse SC. Such structure can be further developed into a well-connected network creating value for the organisations involved (e.g., Romero and Molina, 2011). Previous research suggested that resource sharing, incentive sharing and information sharing among SC members play a key role in encouraging participation and further investment into the collaboration and thus the committed relationship (e.g., Daugherty et al., 2001; Ramanathan and Muyldermans, 2010; Toktay et al., 2000). Based on the existing literature (Balakrishnan and Ramanathan, 2021; Sciarrotta, 2003), we advocate that the interest of collaborative SC members in sustainability improvement programmes, such as sharing of digital resources and investments in sustainable operations, will further encourage the commitment of SC members in CLSC collaborations. Therefore, we formulate the next hypothesis as follows:

Hypothesis 4. Interest in sustainability will be significantly related to the commitment of SC members in CLSC collaborations.

Previous research suggests that collaborative activities between SC partners will lead to higher level commitment and trust between partners (Nyaga et al., 2010; Ramanathan et al., 2021a, 2021b), which are important indicators of embedded relationships (Uzzi and Lancaster, 2003). Such embedded relationships are normally coupled with higher levels of knowledge sharing and reciprocal exchange (Uzzi and Lancaster, 2003). More involvement in collaborative activities can facilitate partners' willingness to engage in further interaction and collaboration. In this study, we argue that SC members' involvement in forward and reverse SC operations has a positive influence on the level of commitment of SC members in such operations. Therefore,

Hypothesis 5. The involvement of SC members in CLSC operations is significantly related to the commitment of SC members in CLSC collaborations.

There is general consensus that more embedded SC relationships will enable better inventory management and more sustainable SC performance (e.g., Albino et al., 2012; Nath and Eweje, 2021). Balakrishnan and Ramanathan (2021) stress the importance of suppliers' involvement in CLSCs to adhere to the sustainability objectives of automobile businesses. In-depth involvement of SC members will encourage better cost/incentive sharing and more intensive collaboration, which will add value to the more effective collaborative relationship between SC members. We argue that such a positive relationship will apply not only to firms' forward SCs but also to reverse SCs, because more involved relationships will reduce risks, potential conflicts, and the cost of forward/reverse SC operations (Gallear et al., 2021). Based on the above arguments, we develop our next research hypothesis as follows:

Hypothesis 6. SC members' involvement in CLSC collaborations will be significantly related to the success of collaboration.

Nyaga et al. (2010) examined SC collaborations from the perspective of both suppliers and buyers. They identified that higher levels of commitment of collaborating partners will lead to better relationship performance. Ramanathan (2013) suggested that higher levels of collaboration, namely 'futuristic collaboration', will support the success of SC operations. However, this 'futuristic collaboration' will be possible only when collaborating partners trust each other and are ready to share quality information with full commitment (Nyaga et al., 2010; Ramanathan et al., 2021b; Wiengarten et al., 2010). This is especially the case in reverse SC operations, since there might be major gaps in policies and understandings between SC members (Waqas et al., 2018). In this study, we argue that SC members' commitment to CLSC collaborations is a precondition for superior SC collaboration performance. Therefore,

Hypothesis 7. SC members' commitment in CLSC collaborations will be significantly related to the success of collaboration.

The above research hypotheses are presented in the collaborative CLSC framework shown in Fig. 1. To test these hypotheses and to verify the collaborative framework, we carried out a case study and a questionnaire survey, which are explained further in the next sections.

4. Research methodology

To generate empirical evidence and to test our hypothesis, we followed a mixed method approach. In phase one, we explored the SC collaboration of CLSC through a case study of an Indian packaging manufacturer. We collected in-depth interview data, which was subjected to content analysis to identify the main themes emerging from the CLSC operations of this company. In phase two, we conducted a questionnaire survey with all the SC customers of this case company to test our hypotheses using Structural Equation Modelling (SEM). Given the complex nature of CLSC operations in different manufacturing sectors, we intended to gain more in-depth information about the phenomenon: hence, we used a purposive sampling approach to select this case company. The data collection and analysis process is explained in detail below.

4.1. Case study company selection and analysis

In an effort to verify the collaborative CLSC framework, we used a real industry observation-based case study to examine CLSC practices of an Indian packaging manufacturing company (JuteCo) and its SC members. As suggested by Voss et al. (2002), the case study approach is particularly suitable for developing new theory and ideas and can also be used for theory testing and refinement. We followed the purposeful sampling approach (Duan et al., 2014) to select this packaging company. Firstly, packaging materials are widely used in the manufacturing, distribution, wholesale, and retail sectors. The huge volume of usage and relatively cheap unit prices mean that the packaging industry poses a great threat to the environment and sustainability performance of SCs. Secondly, there is a high volume of reverse SC operations due to product

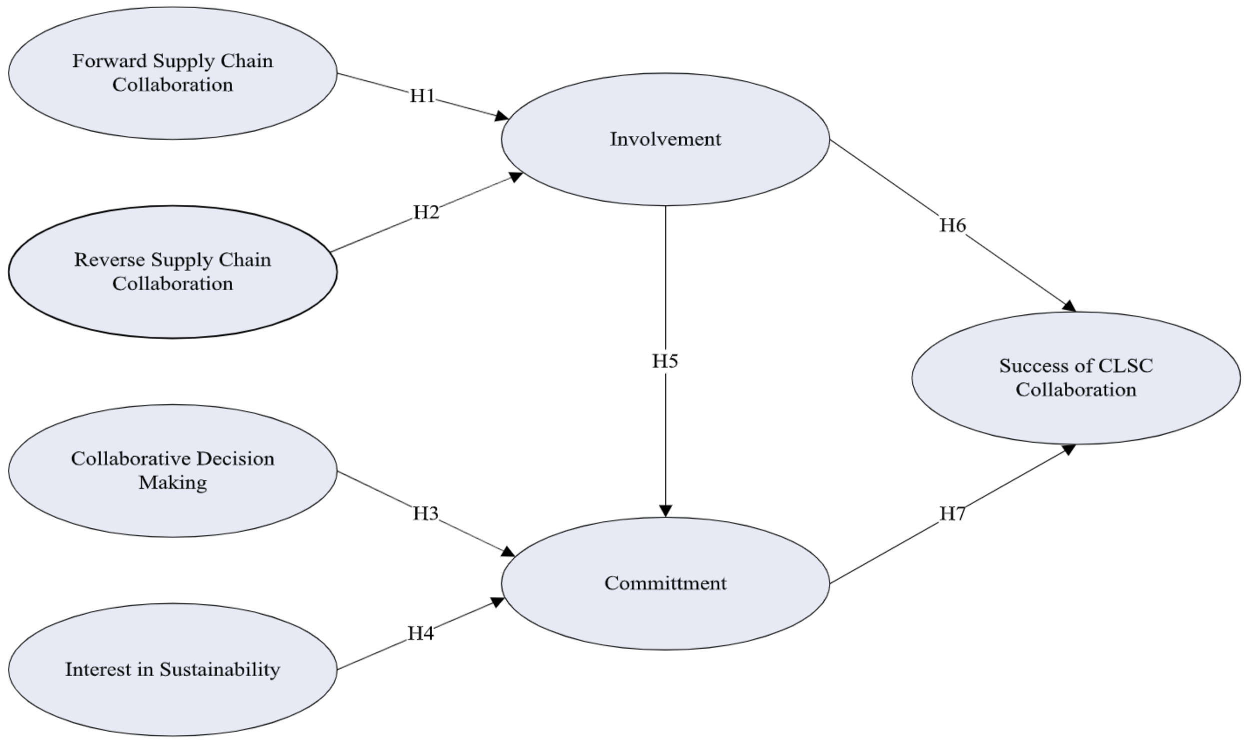

Fig. 1. Collaborative CLSC framework.

returns and end-of-life product returns, along with the forward SC operations for new or reprocessed products, which means that the company needs a high level of reverse SC capability. This is very much in line with our research objective of unveiling CLSC collaborations in industrial settings.

On the basis of the collaborative CLSC framework we developed, we attempted to acquire insight into CLSC operations and challenges faced by the company and its SC members during collaborations. We used the 'case observation' approach (Voss et al., 2002; Yin, 2009) as the primary way of identifying the current CLSC practices in the case company, including operations and processes involved in reverse SC operations. This approach led us to develop a better understanding of the actual practices of CLSC collaborations. The case observation involved nine field visits to the case company and direct interactions between researchers and senior representatives of 10 members of the JuteCo SC through informal face-to-face meetings and telephone calls between 2011 and 2020. In addition, we conducted three in-depth semi-structured interviews with one CEO equivalent) and two operations managers of JuteCo to enable data triangulation and to enhance the validity of the observation findings. One of the operations managers of JuteCo was responsible for remanufacturing and recycling of products sold outside Asia (mainly in European countries) and the other operations manager was in charge of recycling within India. Each interview lasted between one and 2 h. The interview transcripts were subject to content analysis by two researchers independently to identify the main themes against the theoretical framework. During this process, we used a keyword search for each response we received from the respondents, assisted by the NVivo10 software. These keywords, such *as closed loop*, *reverse*, *logistics*, *recycle*, *remanufacture*, *supply chain*, *reverse supply chain*, *partner*, *collaboration*, *cooperation*, *profit*, *incentive*, *sharing*, *cost effectiveness*, *risk*, and *trust*, were used as initial codes to identify the emerging themes. These codes were further refined to identify other emerging themes. This was an iterative process involved revising the search keywords, adding new keywords, and removing existing keywords, as well as moving and combining emerging themes while reviewing the interview transcripts, until no new themes were emerging. SC collaboration, reverse SC and value creation (profit) were some of the main themes that emerged from the content analysis. The emerging themes obtained by the two researchers were compared. Over 80 % consistency was achieved, thus confirming inter-rater reliability. Any differences in understanding or meaning were synchronized after information collation.

4.2. *Supply chain collaboration in the packaging company*

JuteCo is an Indian manufacturing company producing ultraviolet (UV) treated jumbo bags that could be used in multiple industries, such as the petrochemical, mineral, dyes, and pharmaceutical industries. Chemical and herbal products are delivered internationally using these bags in large packaging bags. Products from these large bags are then transferred into many small bags to be transported locally to various sites to make different chemicals or medicinal products. In such cases, UV-treated bags have high functional value to maintain the quality of the contained products. Each Jumbo bag can carry up to 2000 kg of materials. The company operates from India, with an annual turnover of about 25 million US dollars. The company held nearly 20 % of the market share in the local packaging industry at the time of the case study. JuteCo maintains a healthy relationship with its customers. The company deals with more than 100 regular customers from around the world. For the past eight years (before the case study was conducted), the company has been collaborating with its downstream SC members for sales and product recycling.

Product returns of Jumbo bags are due to three main reasons: misspecification, end-of-life (non-usable in original forms) and end of UV effect (see Fig. 2). Previously, the local government's green agenda forced JuteCo to introduce reverse logistics processes to handle product returns and end-of-life product recycling. Product recycling is also encouraged by JuteCo's customers. Products returned for reasons of misspecification will normally be sold in another market. Instead of disposing of used bags, JuteCo tries to extend their life by applying UV treatment and also by increasing the thickness of bags. Bags that have the potential to be upgraded (for example, bags that need UV treatment) will be processed with UV rays and will be resold in the same market for

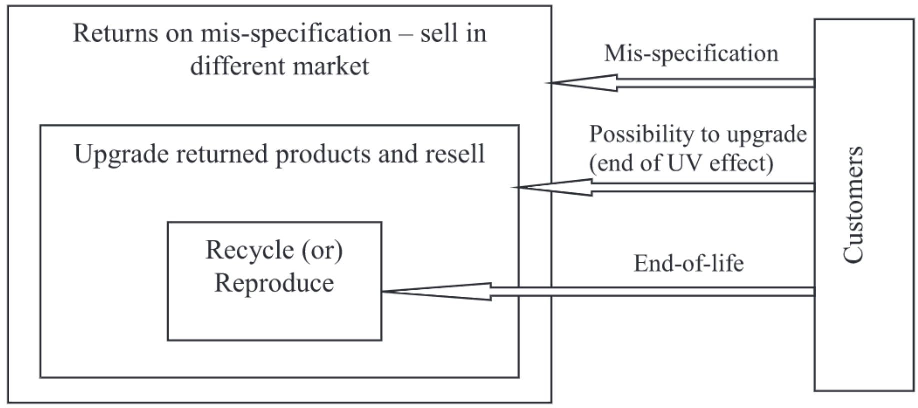

Fig. 2. JuteCo's operational improvement programme.

cheaper prices or sold to other customers with smaller profit margins. Other end-of-life product returns are recycled and used as raw material for further production of Jumbo bags.

To reduce costs while satisfying environmental regulations, the company uses the same logistics providers for both forward and reverse SC operations, because JuteCo expects that the same logistics providers would understand the nature of products and product returns better and could respond more quickly to reverse SC requests. Such arrangement has helped both sides to form a close collaborative relationship over the years and effectively reduced the cost of handling returns.

Moreover, from 2004, JuteCo adopted a new recycling programme by entering into the engineering field of backward integration process. Backward integration is a process of converting polypropylene into fabric, which is one of the main raw materials for Jumbo bags. This programme has helped JuteCo to save cost on raw materials and also enabled the company to become partially self-sufficient in terms of raw materials. For example, this method of backward integration has helped the company to improve production flexibility and to reduce the lead time by up to 25 %. JuteCo has been enjoying the freedom of scheduling of production of Jumbo bags based on their own raw material – fabric production; this has helped the company to reduce inventory costs and freight charges.

These approaches of recycling and remanufacturing are not only environmentally friendly, but also allow continuous operational improvement in CLSCs, as well as allowing the company to improve customer satisfaction by offering incentives across the SC. These approaches are also in line with the circular economy concept, which encourages value addition in the process of waste-to-energy recycling (European Commission, 2015). For example, SC members with good long-term commitment are rewarded with discounted prices for their involvement in reverse SC operations, such as returning used bags and buying recycled bags at discounted prices. This discount accounts for a minimum of 10 % to a maximum of 15 % of the sales price, which serves as a very big incentive for SC members to continue to be involved in reverse SC operations.

During SC collaborations, information exchange with SC members is found to be essential for JuteCo to be more responsive to future orders. However, not all the information exchanged is actionable without prior planning. For example, the requirement for bags with 'variable thicknesses' cannot be fulfilled immediately without planning and scheduling, because it may also require additional machinery in production to avoid loss in sales. At times when JuteCo fails to match customers' requirements at demand, product returns will be incurred. For this reason, JuteCo is interested in establishing intensive collaboration with customers during the planning stage for product specification, which can continue into the production and replenishment processes. For production planning, JuteCo uses informational input from its customers for design and specifications such as size, weight tolerance and UV treatment. Such collaboration between JuteCo and its customers enables the company to produce more precisely according to customers' requirements and to replenish stock on time.

Most of JuteCo's communication with its upstream and downstream SC members is conducted through iMail Server. This is a form of advanced low-cost communication technology in India, which works well independently or in the presence of other servers, such as email servers, SMTP, POP3 and IMAP. The company's recent upgrade to its ICT technology has proved effective in reducing the complexity in communication with SC members. JuteCo believes that its recent investment will improve its communication and help to avoid replenishment delays.

The case of JuteCo specifies that CLSC collaboration help the company to reduce cost and to improve profitability. For example, after implementing CLSC collaboration, JuteCo has benefited from nearly 50 % growth in sales (see Fig. 3). Finding and securing sales opportunities in primary and secondary markets was a challenge for JuteCo before this SC collaboration. Now, SC collaboration helps the company to manage this task effectively through the collaborative efforts of SC members.

Moreover, JuteCo's incentive policy encourages its SC members to be involved in reverse SC operations as part of their own operations. For example, committed customers are rewarded with discounted prices for their involvement in reserve logistics operations. This has helped JuteCo to attract and retain many customers from around the world. The case of JuteCo shows the importance of SC collaboration to effective CLSC operations. Despite that, effective communication remains essential to enable companies to collaborate for successful reverse SC operations. Moreover, the collaboration between JuteCo and its SC members creates its own virtuous cycle, as the more involved the SC members are in CLSC collaborations, the more committed they become, because both sides of the SC relationship tend to share more incentives for collaboration and higher levels of investment in the relationship.

4.3. CLSC during the Covid-19 pandemic

During the recent Covid-19 outbreak, it is surprising to know that UV treatment service for returned products of packaging bags was temporarily suspended due to the shortage in labour and lockdown measures. The workforce involved in collecting and remanufacturing Jumbo bags has been struggling to cope with the ongoing issue of Covid-19. Also, because of employee health and safety considerations, the company's top management decided not to collect any used bags from customers via its main manufacturing facilities. A new set of operational strategies was implemented to avoid the transmission of the virus during product returns and remanufacturing of bags. However, the company made other arrangements to retain recycling operations through local recycling points. This service was extended through close collaboration with its SC partners. It is interesting to see that due to the shortage of raw

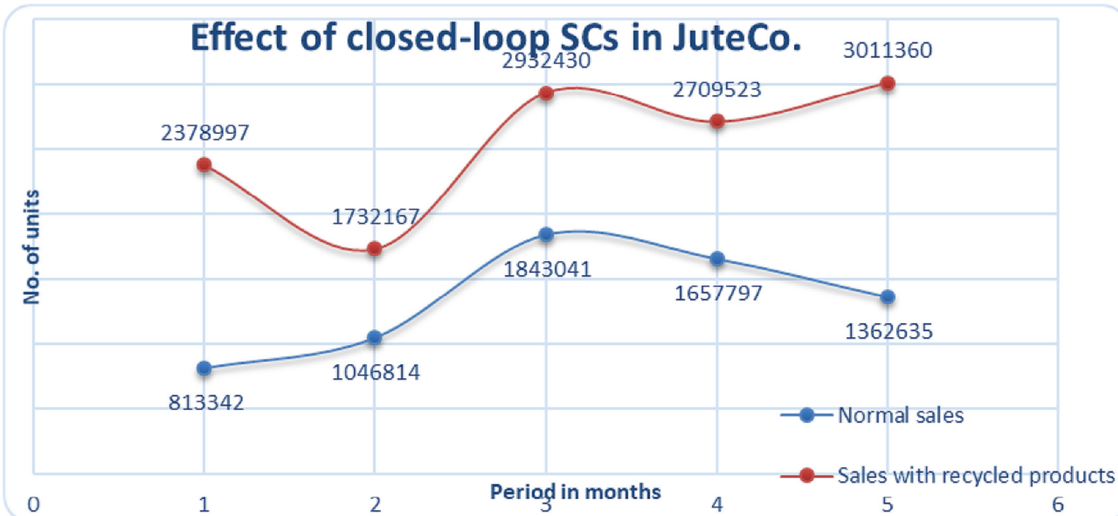

Fig. 3. Normal sales and sales after adopting CLSC collaboration.

materials in the market and the rapid rise in prices for such materials, the company and its SC partners have found CLSC operations even more important and beneficial. The turnaround time of the company's decision on recycling became much quicker during the pandemic, and hence the sustainability objectives were well protected. In this sense, the company has been championing its CLSC arrangement in a different way.

4.4. Case summary

Overall, the case findings provide initial support for the collaborative CLSC framework. In our interactions with ten members of the JuteCo SC, they all highlighted the importance of collaborative information sharing and decision-making for both forward and reverse SC operations for better commitment to both forward and reverse SC collaborations. We also found that the performance of handling product returns (e.g., repairing/reselling/recycling) will be improved if SC members have gained prior knowledge through collaborative information sharing. This was enhanced by working with the same SC partners for both forward and reverse SC operations. Higher levels of involvement between SC members are more likely to facilitate joint problem identification and problem solving. Moreover, customers of JuteCo are more likely to participate in cost saving reverse SC initiatives when they have previously had interests in and been involved with similar sustainability initiatives or have ongoing collaborations with JuteCo. Financial incentives, such as discounted sales, will encourage better rates of return and recycling when the same collaborative SC members are used. For effective commercial returns and end-of-life returns, JuteCo would expect sufficient levels of involvement and commitment from its SC members.

5. Survey questionnaire

Following the case study, we conducted a structured questionnaire survey with senior managers of JuteCo and its SC members (all identifiable customers) to collect further evidence of the role of SC collaborations in CLSC. The theoretical framework and hypotheses were tested based on Structural Equation Modelling (SEM).

5.1. Survey administration

JuteCo has around 10 suppliers and 140 identifiable customers (buyers) with longer-term business relationships. Unlike Nyaga et al. (2010), who conducted a survey with both suppliers and buyers, we restricted our focus only to collaborations between JuteCo and its customers. This is because JuteCo's supplier base comprises only 10 firms, and is thus too small to form a meaningful statistical comparison with the collaboration with customers. Moreover, in our study, we only considered customers of JuteCo operating in the packaging industry which were either buyers or direct users of packaging. This approach ensures better focus to bring out different customer perspectives on similar SC collaborative arrangements while avoiding confounding effects when comparing different arrangements in different industry sectors.

The list of identifiable customers (140) that use UV treated bags from JuteCo was obtained from JuteCo to form the sampling frame. The contacts of customers were further verified and complemented with public databases. The questionnaire was pilot tested with five field experts and three senior managers of JuteCo to ensure clarity, accuracy of wording, and ease of understanding by respondents in the sector. Following the pilot test, we sent a structured survey questionnaire with 20 items to all 140 identifiable customers of JuteCo.

With the assistance of JuteCo, the response rate to the questionnaire was high (above 78.6 %). We obtained 110 responses from 140 delivered questionnaires; the remaining 30 respondents did not respond or were not reachable because they had gone out of business since the initial case study fieldwork. The final dataset consisted of 101 completed responses. Non-response bias was checked using the 'mean difference' test to compare early and late responses (Armstrong and Overton, 1977). No significant mean differences were evident, thus suggesting that non-response bias was not an issue.

5.2. Measurement items, reliability, and validity

The questionnaire survey instrument was developed based on case study findings and relevant literature. A total of 20 measurement items were used to indicate five first-order latent variables (constructs). These variables were named as follows: forward SC collaboration (FSCC) (Ireland and Crum, 2005), reverse SC collaboration (RSCC), collaborative decision-making (CDM), and interest in sustainability (INT) (Ellinger et al., 2000; Ramanathan and Muyldermans, 2010). In particular, although reverse SC collaboration and collaborative decision-making are becoming common in practice, these two variables are not discussed in great detail in the previous literature. Therefore, we composed these two constructs based on the existing literature and the case study findings. Each of these two constructs was indicated by five items (see also Table 2). We also considered two second-order constructs, namely commitment of SC members in CLSC collaborations (CMM) (Nyaga et al., 2010) and involvement of SC members in CLSC collaborations (INVM) (Wiengarten et al., 2010). Similar to previous approaches of Mishra and Shah (2009) and Ramanathan and Muyldermans (2010), we measured these two second-order constructs through the first order constructs. We measured collaboration success in terms of sales growth and new business initiatives (Ramanathan and Gunasekaran, 2014). We used five-point Likert type scales (1—strongly disagree and 5—strongly agree) for all measurement items (see Appendix A for the list of survey items). Table 1 reports the inter-correlations among constructs and related composite reliability values. Composite reliability values for all first-order latent constructs were above 0.9 (diagonal elements in Table 1), and hence support the extent to which items in each construct consistently measure the corresponding latent variables (Hair et al., 2006).

Two first order constructs — FSCC (five observed variables) and RSCC (five observed variables) — explain the involvement of SC members in collaboration for CLSC (INVM). Two first order constructs — CDM (five observed variables) and INT (three observed variables) — explain the commitment of SC members in collaboration for CLSC (CMM).

Principal component analysis with the varimax rotation method and Kaiser normalization was conducted using SPSS 15 to identify and confirm the different observed measurement items underlying each latent construct in the theoretical framework (Ramanathan and Muyldermans, 2010). An eigenvalue of one or more was used to identify the number of factors. Any variable with a factor loading smaller than 0.4 was not considered for further analysis, as it would not measure a specific construct (Hair et al., 2006). Table 2 shows the measurement items and also reports the descriptive statistics, Cronbach's alpha values, and factor loadings.

As shown in Table 2, all the Cronbach's alpha values were above 0.8. Similarly, all the composite reliability values were above the threshold of 0.7 (Fornell and Larcker, 1981) (see Table 1), hence suggesting satisfactory reliability of the constructs (Hair et al., 2006; Nunnally, 1978). As shown in Table 2, all the observed variables under four constructs, namely FSCC, RSCC, CDM and INT, were found to be significant, with factor loadings above 0.7 (Fornell and Larcker, 1981; Hair et al., 2006). Moreover, the percentage of variance explained was examined to assess the construct validity of the instrument (Fornell and Larcker, 1981). The total variance explained by each construct was in the range of 77.70 % to 97.73 % (see Table 2). The results showed that measurement items had satisfactory convergent validity (Hair et al., 2006).

Measurement items were further tested for discriminant validity to check how each first-order construct was distinct from the others (Anderson and Gerbing, 1988). Since none of the confidence intervals for the inter-construct correlations contained a value of 1.0, we concluded that each construct was distinct (Mishra and Shah, 2009). Moreover, each of the constructs described in the model was explained well by corresponding measurement items. This is also supported by the high R^2 values (see Table 2).

Common method bias was largely avoided in the responses, because all the responses were collected through the focal company from its customers at different times when they were placing orders (Podsakoff et al., 2003). Furthermore, since we used a single set of industry data, we checked the data for common method bias using Harman's single factor test in SPSS. A single factor explains less than 27 % of the total variance, thus suggests that no general factor is apparent and common method bias is not a threat to the analysis (Andersson and Bateman, 1997).

Table 1
Inter-construct correlations and composite reliability.

Constructs	FSCC	RSCC	CDM	INT	Collaboration success
FSCC	**0.963**				
RSCC	0.920**	**0.961**			
CDM	0.882**	0.955**	**0.957**		
INT	0.815**	0.745**	0.755**	**0.912**	
Collaboration success	0.917**	0.877**	0.884**	0.863**	**0.988**

N = 101. **- Correlation is significant at the 0.01 level (2-tailed). Diagonal elements in bold represent composite reliability.

5.3. Hypothesis testing

Similar to Llach et al. (2013), who used Structural Equation Modelling (SEM) to establish the relationship between quality management and firms' environmental performance, we used the SEM approach to test the relationship between various constructs of the theoretical model specified in Fig. 1. We used Amos 18 to develop structural equation models and PASW Statistics 18 for descriptive analysis.

The model fit was evaluated using normed chi-square (χ^2/df), comparative fit index (CFI), goodness-of-fit index (GFI), and root mean square error of approximation (RMSEA) at a 90 % confidence interval (CI). The test statistics shown in Table 3 suggest a satisfactory model fit (Kline, 1998). Table 3 also lists the estimated coefficients of structural paths and the significance levels, as indicated by *p*-values.

As shown in Table 3, the path coefficients between FSCC and INVM (0.71) and RSCC and INVM (0.36) were both positive and significant. Therefore, hypothesis 1 and hypothesis 2 are supported. Both forward and reverse SC collaborations are linked with the involvement of SC members in CLSC operations. The path coefficients between CDM and CMM (0.29) and between INT and CMM (0.53) were also positive and significant, which means that collaborative decision-making as well as interests in sustainability are significantly related to the commitment SC members in CLSC collaborations. Therefore, hypothesis 3 and hypothesis 4 are supported. Since the path coefficient between INVM and CMM was not significant, hypothesis 5 is not supported. Therefore, involvement of SC members (i.e., collaboration action) is not necessarily linked with commitment of SC members (i.e., intention to continue) during CLSC collaborations. The positive and significant path coefficient between INVM and 'collaboration success' (0.68) suggests that hypothesis 6 is supported. Hence, the involvement of SC players in CLSC collaborations positively influences the SC collaboration performance. Similarly, the significant and positive path efficient between CMM and 'collaboration success' (0.56) suggests that hypothesis 7 is also supported. Therefore, the commitment of SC members in CLSC collaborations is positively related to the performance of their SC collaborations.

Moreover, because there is a positive relationship between INVM and 'collaboration success', but not between INVM and CMM, there is evidence that commitment of SC members in collaborative CLSC is not mediating the relationship between involvement of SC members and the success of their SC collaboration. Therefore, 'involvement' and 'commitment' are independently influencing the performance of CLSC collaboration (Fig. 4).

6. Discussion

The importance of 3BL for businesses cannot be overlooked. In this regard, many businesses have come to support the initiation of SC collaborations to reduce their social and environmental impact while improving the business performance of their SCs. Products with shorter product lifecycles, produced in large quantities, become obsolete more quickly and will enter into the waste system, causing more significant value losses and environmental impacts (Guide and Van Wassenhove, 2001; Daugherty et al., 2001). We found in the current study that SC members of JuteCo do engage in collaborative CLSC initiatives to avoid value losses and to maximise value regeneration through better recycling of returned or end-of-life products.

Our findings confirmed that collaborations between SC members of JuteCo in forward and reverse SC operations encourage further involvement of SC members in forward and reverse SC collaborations.

Table 2
Exploratory factor analysis loadings, reliabilities, and percentage of variance explained.

Constructs	Variables	Mean	SD	Variance explained (%)	Factor Loadings	Communalities	R-square
FSCC	Front-end agreement	3.40	1.35	84.106	0.923	0.852	0.700
α = 0.952	Collaborative planning	3.58	1.11		0.972	0.945	0.980
	Collaborative production	3.30	0.90		0.881	0.776	0.670
	Information sharing	3.30	1.10		0.935	0.875	0.856
	Collaborative replenishment	3.78	0.87		0.870	0.757	0.696
RSCC	Product returns promise	3.11	1.05	83.126	0.923	0.852	0.700
α = 0.949	Use of same operators/3PL	3.80	0.87		0.841	0.707	0.497
	End-of-life returns agreement	3.80	0.98		0.906	0.821	0.825
	Information sharing-returns agreement	3.01	1.42		0.940	0.883	0.921
	Product recycling agreement	3.80	0.98		0.945	0.893	0.949
CDM	Warehousing	3.59	0.80	81.668	0.915	0.838	0.841
α = 0.943	Timely delivery	3.90	0.94		0.972	0.944	0.427
	Collaborative forecasting	3.51	1.03		0.849	0.720	0.632
	Joint replenishment	3.31	0.90		0.905	0.820	0.699
	Cost savings	4.30	0.64		0.872	0.761	0.717
INT	Resource sharing	3.51	0.83	77.698	0.795	0.632	0.260
α = 0.854	Incentive sharing	3.39	1.07		0.905	0.819	0.375
	Investment	3.70	1.10		0.938	0.880	0.675
Collaboration success	Sales growth	3.90	1.04	97.733	0.989	0.977	0.577
α = 0.967	New business initiatives	2.71	1.28		0.989	0.977	0.815

Table 3
Coefficients of structural paths.

Structural paths	Coefficient	Significance (p-value)
Forward supply chain collaboration (FSCC) →	0.71	0.000
Involvement (INVM)	0.36	0.000
Reverse supply chain collaboration (RSCC) →	0.29	0.001
Involvement (INVM)	0.53	0.000
Collaborative decision-making (CDM) →	0.68	0.000
Commitment (CMM)	0.56	0.001
Interest in sustainability (INT) → Commitment (CMM)	—	Not significant
Involvement (INVM) → Collaboration success		
Commitment (CMM) → Collaboration success		
Involvement (INVM) → Commitment (CMM)		

Note: SEM model fit indices $\chi^2/df = 3.21$, GFI = 0.913, CFI = 0.910, RMSEA at 90 % confidence interval = 0.042.

Moreover, SC members' collaborative decision-making and interest in sustainable investment and resources/incentives sharing will facilitate the commitment of SC members in forward and reverse SC collaborations. Such involvement and commitment in CLSC collaborations will further support the better performance of collaboration between SC members. This is in line with the RBV, which implies that some resources and capabilities that reside in interfirm collaborations can only be developed over long periods of time (Barney, 1991). In this paper, we suggest that CLSC collaboration will portray important capabilities for SC members. Such capabilities need to be built on sufficient involvement and commitment of SC members.

It is worth noting that 'hidden' operations, such as product returns and reverse SC, may not generate immediate financial benefits to firms, especially if shares of benefits and costs are not clarified, which can be a major obstacle to SC members' participation in CLSC operations. The current study suggests that CLSC collaborations can generate benefits for SC members if the right level of engagement from SC members is present.

In line with previous research, we found that common benefits of SC

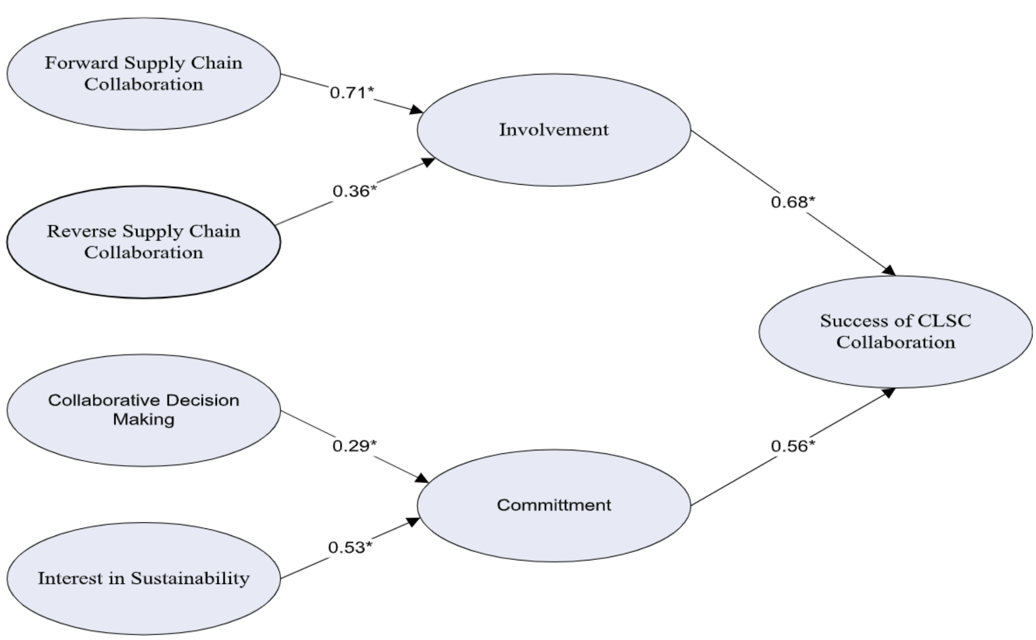

Fig. 4. Significant paths model.

collaboration are identified as reduced inventory levels, lower transportation and warehouse costs, shorter lead times, increased productivity, and lower manufacturing costs (Horvath, 2001). In this study, we found that forward and reverse SC collaborations will lead to better SC collaboration performance, as indicated by higher sales growth and better new business initiatives of the focal company and its SC members. For example, the benefit of JuteCo after implementing CLSC collaboration was enormous, as indicated by nearly 50 % growth in sales (see Fig. 3). CLSC collaboration helped JuteCo to secure market opportunities and manage both primary and secondary markets more effectively, which was once a big challenge for the company.

The current study confirms the positive role of SC members' involvement and commitment in CLSC collaborations. However, the findings suggest that SC members' involvement in CLSC collaborations (action) does not always lead to their commitment (intention) towards CLSC collaborations. Accordingly, active participation of SC members in CLSC may not automatically lead to their commitment in CLSC initiatives. Hence, the involvement and commitment of SC members should be treated as independent facilitators when collaboration strategies are designed. Companies will participate and show commitment in CLSC collaborations only if they are involved in joint decision-making and the incentives are explicated and assured when processing/using recycled materials or products.

Interestingly, during the Covid-19 pandemic, although reverse SC operations were heavily affected in the main facilities of JuteCo, reverse SC operations were decentralized and continued in JuteCo's SC partners. Such continued effort was largely ensured by the commitment to this CLSC collaboration from JuteCo's SC partners, which originated from trust and recognition of business priorities, which was built over time during the pre-pandemic period, in addition to the pressures from material shortages and the significant price inflation of raw materials. In this sense, CLSC collaboration has shown a certain level of resilience against emergent situations, such as the Covid-19 pandemic.

7. Practical implications

The results of our study provide practitioners of the CLSCs, especially in the traditional manufacturing sectors, with following suggestions: Firstly, continued involvement of SC members in CLSC collaborations facilitates better collaboration performance. Effective cooperation on forward SC planning as well as the establishment of reverse logistics routines/agreements are needed to pave the way for continued involvement of SC members in CLSC collaborations.

Secondly, SC members may not show enough commitment to CLSC activities unless they are engaged in collaborative decision-making, have the willingness to invest in sustainability initiatives, and are ready to share resources and incentives (c.f., Olorunniwo and Li, 2010).

Thirdly, such willingness in sharing and relationship investment can be facilitated when the same SC members are used for both forward and reverse SC processes. Mutual understanding and engagement are maximised because the same members are dealing with the same range of products in forward and reverse processes. This is not only because of the economies of scale in product handling, but also because of the capability to more effectively trace and track product returns and underlying issues (especially during disastrous situations such as the COVID-19 pandemic), such that the efficiency of CLSC can be improved at a lower cost. Such unified collaboration will also ensure that the root of problems causing product returns can be quickly identified for future product and process improvement.

Fourthly, evidence from the case of JuteCo further suggests that incentive sharing schemes, such as discounted sales, will explicate the benefits of reverse SC efforts by integrating financial incentives into the business models. This will help SC members to build confidence about reverse SC collaborations, so as to be more committed to CLSC initiatives.

Fifthly, in order to enhance commitment from SC members, long-term plans for incentive sharing need to be in place. For CLSC operations which involve more complex processes, SC members need to build enough confidence on fair shares of responsibilities, costs, and benefits before they can build long-term commitment to CLSC initiatives. As indicated in previous studies, trust building is also needed to enable SC members to show better commitment (Nyaga et al., 2010). This also implies that managers should pay more attention to the establishment of fair agreement and collaboration mechanisms, which enhance SC members' trust in the ongoing CLSC initiatives, so as to prolong the collaboration.

Moreover, we have gained evidence that CLSC collaborations had a certain level of resilience during the COVID-19 pandemic. Companies retain CLSC collaborations not only because of the continued commitment from SC partners, but also because such practices can generate benefits that would otherwise not be achievable when there are material and labour shortages during disastrous times. In this sense, global supply chains can add specific code of practice for developing resilience with all operations. This can also include a detailed mitigation pathway for unexpected complexities within their operations to shape the future of all businesses.

8. Limitations and future research directions

It is worth pointing out that our empirical work is context-specific, because it is based on a study of the SC network of one packaging manufacturer in India. However, our study reveals evidence of CLSC collaborations from a traditional industry, which can be replicated in other industries. Further research with larger-scale empirical data can convey the impact of collaborative CLSC in different industrial and national settings. Moreover, due to limited access to data, we did not examine other conditional factors or moderators that might affect the hypothesized relationship. For example, our study focused on the CLSC phenomenon from an interfirm collaboration perspective only: the impacts of other human-related collaborative factors, such as top management commitment, the role of boundary spanners, and microfoundations of collaborations, were not examined. Future research is needed to explore these factors as potential moderators of our hypothesized relationships through more in-depth empirical studies.

9. Conclusions

SC collaboration is increasingly common in all businesses. The success of SC collaboration in forward SC operations, especially at the time of the global pandemic, is evident in the literature (e.g., Sajjad, 2021; Sarkis, 2021; Smith, 2006). However, until recently, the extant literature has paid limited attention to the 'hidden' operations of reverse SC operations, which are less visible to customers and tend to be ignored by businesses. We recognize that the volume and value of product returns in the current era is increasingly significant due to various factors, such as regulations favouring consumer care, severe market competition, and longer business allowance for consumers to return products. Hence, investing in CLSC solutions and capacities and engaging in SC collaborations has become a necessity.

Our study proposes and verifies a collaborative CLSC framework based on the RBV. We have attempted to explore the concept of CLSC collaboration by taking an integrated view of forward and reverse SC collaborations through an observation-based case study and a questionnaire survey. The empirical study helps to generate better understanding of CLSC operations of a packaging manufacturer and the determinant factors of successful CLSC collaborations.

Overall, the main findings of our research contribute to the literature of CLSC and collaboration by clarifying that: 1) the success of CLSC collaboration lies in the involvement and commitment of SC members in collaborations; 2) collaboration for *forward* and *reverse* SC operations facilitates the involvement of SC members in CLSC collaborations; 3) SC members involved in CLSC collaborations are not necessarily committed to these collaborations, unless they are engaged in collaborative decision-making, have an interest in sustainability investment, and are ready to share resources and incentives; and 4) such willingness is enhanced by collaborative decision-making, explicit incentive sharing schemes, and the use of the same SC members for both forward and reverse SC operations.

Hence, our paper extends the previous research by explicating the mechanisms of interfirm collaborations in ensuring CLSC collaboration success and provide further evidence of the importance of collaboration in generating values or reducing costs in SC relationships, especially from 'hidden' reverse SC operations. Our findings also confirm the benefit of integrating reverse and forward SC collaborations as important components of the CLSC strategy. This is in line with previous literature which suggests that SC collaboration will lead to better SC performance (Albino et al., 2012; Droge et al., 2012), but further suggests that such interfirm collaborations should be extended to both forward and reverse SC operations. In this sense, this study extends the application of the RBV (Barney, 1991) into the context of CLSC collaborations.

The main message for practitioners is that reverse SC operations may be not just a nuisance, but a necessary evil (Daugherty et al., 2001). There is a lot of potential to be tapped in the manufacturing sector to retain and re-generate value through CLSC collaborations, especially for companies which produce large volumes of product returns or end-of-life product waste. Previous studies advocate that interfirm collaborations in reverse SC operations can solve many problems in SCs and also remove deficiencies in processes (Jayaraman et al., 2008; Sarkis, 2021). In this study, we further clarified that the commitment from SC members in terms of collaborative decision-making, resource sharing, incentive sharing and investment in sustainability will enhance the collaboration performance of SC members. Moreover, in line with previous studies (e.g., Jayaram and Tan, 2010), we suggest that companies handling reverse SCs can use the same 3PLs or logistics service providers for both forward and reverse SC operations, in order to retain more value from product returns and end-of-life returns, and to better identify the root problems causing unnecessary product returns.

We concede that the adoption of sustainability practices in manufacturing is still very uneven across different countries and different industries. Nowadays, CLSC is becoming increasingly common among companies which practice recycling, re-using, and remanufacturing, especially in developed countries. CLSC is also believed to be more common for technology intensive industries, such as automobile and electronics (Chan et al., 2012; Sciarrotta, 2003). However, our study confirms the potential for traditional industries in emerging economies (in our case, a packaging manufacturer in India) to also benefit from collaborative CLSC practices.

CRediT authorship contribution statement

Usha Ramanathan: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Supervision; Roles/Writing - original draft.

Qile He: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Validation; Roles/Writing - original draft; Writing - review & editing.

Nachiappan Subramanian: Conceptualization; Formal analysis; Supervision; Roles/Writing - original draft.

Angappa Gunasekaran: Conceptualization; Supervision; Roles/Writing - original draft.

David Sarpong: Writing - review & editing.

Data availability

Data will be made available on request.

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Appendix A. Survey items

Forward SC Collaboration

1. We have interest in front-end agreement with JuteCo.
2. We engage with JuteCo on collaborative planning.
3. We engage with JuteCo on collaborative production.
4. We have information sharing with JuteCo for demand forecasting.
5. We practice collaborative replenishment with JuteCo.

Reverse SC Collaboration

6. We are interested in reverse SC activities with JuteCo.
7. We use same SC operators/3PL for reverse logistics and forward logistics operations with JuteCo.
8. We collaborate with JuteCo for disposing end-of-life product returns.
9. We practice information sharing with JuteCo on product returns.
10. We have collaboration with JuteCo on product returns and recycling.

Collaborative Decision Making

11. We have collaborative decision-making with JuteCo on warehousing.
12. We have collaborative decision-making with JuteCo on timely delivery.
13. We use collaborative forecasting with JuteCo.
14. We work with JuteCo for joint replenishment.
15. We have collaborative decision making with JuteCo on cost savings.

Interest in Sustainability

16. We have interest in resource sharing with supply chain partners for sustainability reasons.
17. We have interest in incentive sharing with supply chain partners for sustainability reasons.
18. We have interest in investing in collaboration (business/technology) with supply chain partners for sustainability reasons.

Success of Closed-loop Supply Chain Collaboration

19. Compared with our main competitors, we have had better sales growth in recent years.
20. Compared with our main competitors, we have had more new projects/new business/new products initiated in recent years.

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