Implementing Circular Economy in the Textile and Clothing Industry

Abstract

This research reveals the current state of the circular economy, challenges and opportunities of implementing circular economy (CE), and interventions that could facilitate effective implementation of circular economy in the textile and clothing (TC) industry. The study uses a survey method within 114 TC companies based in Bangladesh, Vietnam and India revealing the correlation of CE fields of action (take, make, distribute, use and recover) with sustainability (economic, environmental and social) performance. The lack of financial, technological, and human resource, along with management's reluctance and end user's indifference to sustainability are the biggest challenges for CE implementation. The research further derives that the TC firms are unable to eradicate the challenges to CE implementation without a holistic approach that involves the collective effort from the industry, host government's incentives, their buyers and above all the conscience of the end-users. Finally, the study reveals that the collaborative efforts, knowledge sharing in sustainability management across the value chain, and marketisation of the waste recycling among others are a few actions the stakeholders of the TC industry must adopt for implementing CE successfully.

KEYWORDS

Circular economy, textile and clothing firms, sustainability practices, economic, environmental and social performance

1. Introduction

The textile and clothing (TC) industry is seen as the first step towards industrialisation (Brenton and Hoppe, 2007). It has enormously benefitted many emerging economies by increasing their export revenue, creating jobs and improving their citizens' living standard. The TC industry's global trade was worth the US $807 billion in 2019 and employed more than 70 million people worldwide in its diverse supply chain (WTO, 2019). Developing countries such as Bangladesh, India and Vietnam rely heavily on their TC industries, as for Vietnam 18% of the total export revenue is generated from garment export (Vietnam Briefing, 2020), and for Bangladesh, it is a staggering 80% (BGMEA, 2020). The social contribution of the industry is also highly commendable, particularly for women empowerment (Ahmed et al., 2014).

Nonetheless, its negative environmental impact is also worrying. It is the second most polluting industries after oil (UN, 2019), with 10% of global greenhouse gas (GHG) emission. Water pollution caused by dying effluent has polluted the river system around TC factories resulted in the destruction of the aquatic ecosystem (Haque and ENRAC, 2017). The industry discharges nearly 20% of the global industrial water pollution and two hundred thousand tons of untreated dye (Sustain your style, 2020). The extent of the population has caused significant deterioration of the groundwater purity as well posing a significant health risk for human and animals alike (Haque and ENRAC, 2017; Mukherjee, 2015; Parvathi et al., 2009).

It is one of the most natural resource-hungry industries due to its use of a vast amount of water (e.g.7000 litres per pair of jeans) (UN, 2019). In the raw material supply chain, it is equally damaging due to the amount of water is required to irrigate the cotton fields. For example, the drying of the North Aral Sea in Uzbekistan is primarily caused by cotton production to feed the global clothing demand displacing communities and destroying the marine lives (BBC, 2015). Soil deterioration, deforestation, microfiber in seawater, chemical additives are some other direct environment cost of the industry. Besides, a conservative estimation suggests that $3 billion worth of clothes and textile products landfilled every year. Strähle and Müller (2017) also identified that fashion logistics, overproduction due to forecasting error, irresponsible consumption and uninformed consumers are responsible for the sustainability gap in the TC industry. The Ellen MacArthur Foundation (2019) forecasted that the industry would use more than 26% of the carbon budget by 2050 if the current linear and wasteful supply chain continues.

In addition, the social sustainability in the TC industry came under severe criticism at the aftermath of the Rana Plaza tragedy in Dhaka that claimed 1135 lives and thousands suffered life-changing injuries (Guardian, 2013). Although many health and safety measures are being implemented at the aftermath, workplace accidents persist as the Bangladesh Institute of Labour Studies (BILS, 2017) reports that nine worker died and 206 (145 female) were injured due to factory hazards. The BILS also indicates unreported daily abuse of workers in the hands of their employers. Sensitivity has grown significantly around the world against such treatment of the workforce. Multinational clothing retailers are under constant scrutiny on the sustainability of their value chain (Taplin, 2014). Stricter regulations are brought mainly in the developed countries so that the polluter bears the cost of sustainability. Besides, social sustainability issues caused by environmental degradation is an area that requires significant attention (Mukherjee, 2015; Parvathi et al., 2009). Academic studies (e.g. Huq and Stevenson, 2018; Huq et al., 2016; 2014) also identified that there is an urgent need for a more sustainability-based practice in the TC industry.

Unfortunately, the irreversible ecological and social damages continue due to the current cost and efficiency-based value chain of the industry. Efficiency is fundamentally synonymous to a reduction in the inputs, including labour and energy, for the production of any particular commodity. Technological inventions to cut lead-time, labour and energy cost are advocated as the most straightforward way for a more efficient supply chain. However, the increasing use of efficient technologies (even green technology) does not lead to sustainability as they reduce the production cost, resulting in lower prices, which eventually lead to higher market demand. The ultimate result is further extraction of natural resources (Freire-González and Puig-Ventosa, 2015). Ethical fashion consumption and sustainable raw material production are not adequate to tackle such environmental degradation (Joy et al., 2012; Laari et al., 2016). Therefore, the issues of sustainability can't be solely resolved by technology and a transition from the linear to circular is necessary to manage the average 1.5° C global warming limit (IPCC, n.d.; Jia et al., 2020).

Sustainability for the TC industry is the preclusion of the negative ecological impacts as well as impairments of the living conditions of workers, users, and stakeholders affected in any manner during the production, use, reuse, and recycling of clothes and treating of clothing waste (Kleinhückelkotten and Neitzke, 2019; Resta et al., 2014). The circular economy (CE) business model aims to prevent the depletion of resources, close energy and materials loops. It facilitates sustainable development at the micro (enterprises and consumers), meso (economic agents integrated into symbiosis) and macro (cities, regions, governments) levels (Geissdoerfer et al., 2017;

Kalmykova et al., 2018). We argue that the TC industry can achieve circular economy through five fields of action – take, make, distribute, use and recover, i.e. converting their linear business processes (make, use and dispose) to circular (Prieto-Sandoval et al., 2018).

The circular economy is a concept widely studied in China and the European Union but in the inception stage in emerging economies (Katz-Gerro and López Sintas, 2019; Türkeli et al., 2018). There are works in larger organisations (Kumar et al., 2019; Zhu et al., 2010) focusing on predominantly manufacturing and construction industries, but more comprehensive study on the adoption of CE in TC industry is required (Suárez-Eiroa et al., 2019). For example, MNCs (e.g. Burberry, Gap, H&M, Inditex) from the global TC industry have recently started implementing CE in their supply chain (Goworek, 2011; Wigley et al., 2012). However, uptake of CE in various tiers of TC supply chain is very slow and challenging because an organisational transformation is necessary to reveal the current state of circularity of the supply chain, and identify issues and challenges, opportunities to implement the CE business model. Therefore, this research bridges this critical research and practice (knowledge) gap. The overarching aim of this research is to facilitate the TC industry in adopting CE. This study addresses three research questions (RQs) -

RQ1: How does the CE fields of action affect the TC industry's sustainability currently?

RQ2: What are the challenges, opportunities and requirements of adopting a CE in the TC industry?

RQ3: How does TC industry adopt CE effectively?

- RQ3a: What strategies to be considered for implementing CE effectively?
- RQ3b: What resources are required to implement CE?
- RQ3c: What action plans must be undertaken to implement CE?

This study adopts a survey data based mixed- method approach by using statistical data and content analysis. Responses from 114 TC manufacturing firms across Bangladesh, India and Viet Nam were analysed to reveal the answers to the research questions. The findings are validated through a focus group consisting various stakeholder of the TC industry.

The paper has been organised as follows – Section 2 critically analyses contemporary research and identifies knowledge gap through literature review, Section 3 demonstrates the methodological steps, section 4 derives the hypotheses and develops the conceptual model, Section 5 analyses the data and presents results and findings, and finally, last two sections are for discussion and conclusion respectively.

2. Literature Review

The circular economy has evolved as a new paradigm to deal with climate change. The CE replaces the 'end of life' concept from a business model with reducing, alternately reusing, recycling and recovering materials in production/distribution and consumption processes (Kirchherr et al., 2017). Thus, contributing to accomplishing sustainable development through, environmental quality, economic prosperity, and social equity. The CE business model operates at the micro-level (products, companies and consumers), meso-level (eco-industrial parks) and macro-level (city, region, national and beyond) (Dey et al., 2020).

The principle of 'reduce, reuse and recycle' is at the heart of the CE based business model. Take, make, distribute, use and recover are the five functions that can reduce the use of raw materials and prompts reuse and recycle outputs (Ormazabal et al., 2016). Firms consume raw materials during the take function and make them into finished products. Distribute relates to making the finished products available to users. Use allows consumers to get benefit from the utility of the products, whereas, recover manages the end of life state of the product through reuse and recycle. These functions should be supported in micro, meso and macro levels. At the micro-level, firms produce sustainable goods and services in separate units. Industry and business associations, clusters, and eco-industrial parks interact and stimulate industrial symbiosis at the meso-level to considerably improve their environmental performance indicators (Daddi and Iraldo, 2016; Ormazabal et al., 2016). Finally, policymakers facilitate adopting CE through the most appropriate regulatory framework at the macro level (Jia et al., 2020).

The TC industry business model is buyer-driven, in which manufacturers are under constant pressure to reduce production costs to stay competitive in the global market (Gereffi, 2002). The presence of buyer-driven value chains is prevalent in industries in which production is labour intensive, non-specialised and requires a low fixed cost. Entry challenges are high in designing, distribution, branding, advertising and market intelligence, but low in the production stage. Hence, maximum bargaining power rests in the hands of the big brand owners, distributors and retailers. Exceedingly high bargaining power of buyers endows them with price-determining power and limited switching costs. Therefore, multinational corporations (MNCs) can significantly control their value chain without much involvement in the manufacturing process, whereas suppliers continuously look for opportunities to reduce production cost. Besides, environmental sustainability in the TC industry is very much driven by regulatory enforcement. The enforcement and audit of environmental compliance can often become symbolic due to the multitier supply chain (Huq et al., 2016).

Therefore, TC firms emphasise more on their economic performance over environmental and social ones, which severely affect the working conditions, health and safety and environmental sustainability. They face demand-side uncertainties, cash flow issues, lack of standardised business practices, skill shortage and higher employee turnover (Prieto-Sandoval et al., 2018). The TC firms' adoption of CE is likely to be constrained by their budget, pressure from their customers and policymakers. Absence or shortage of financial support, information management system, necessary technology, consumer interest, government support and managerial commitment to the environmental cause, and professionalism in ecological management (Rizos et al., 2016; Ritzén and Sandstrom, 2017).

Nonetheless, The TC manufacturers can be benefitted from the CE adoption through the increased image, cost reduction, business growth, higher productivity, recovery of the environment through reduced CO2 emission, substantial reduction of water, effluent and power usage, and albeit greater sustainability (Su, 2013; Wigley et al., 212). On the other hand, Dey et al. (2020) and Prieto-Sandoval et al. (2018) proposed 13 action points for the CE implementation, as demonstrated in Table 1. However, these need synergistic among all the stakeholders across the supply chain, including policymakers.

Table 1 about here

Successful implementation of CE depends on several internal and external factors. External factors include public policy, market conditions, technological development, and stakeholders; whereas internal factors are the firm's resources, capabilities and competencies (Prieto-Sandoval et al., 2018). In the take field, the resources are procurement department, materials database, design and creativity, human resource department, and competences are abilities for eco-design and to attract talents with environmental values. In the make field, the resources are machinery and equipment, design, production technology, and competences are production and project management. In the distribute field, traceability systems is the resource and competencies, the ability to perform reverse logistics, manage traceability, and share logistics operations with other organisations. In the use field, the resources are business intelligence for market analysis, maintenance services platform, and communication channels; and competences are green marketing initiatives, including the consumer in product design, and maintenance services offer. In the recover field, the resources are reusable and recyclable products and materials, and competences are the ability to design circular processes and products (Prieto-Sandoval et al., 2018).

The studies of Katz-Gerro and Sintas (2019) demonstrate that suppliers (mainly SMEs) in various tiers of large businesses undertook waste minimisation, re-planning of energy use, redesigning products and services, using renewable energy, and reducing water usage to achieve CE. Such adoption of the CE is often enforced by regulation, as it was in this case. Yet, the outcome was cost saving which provided a stronger impetus for other business to replicate CE practice (Prieto-Sandoval et al., 2018). Therefore, three factors that are associated in adopting CE within TC supply chain are material provision, resource re-utilisation and financial advantage (Ünal et al., 2019).

The need for sustainability in the TC industry is widely acknowledged in academic and practice literature, as demonstrated above. The most significant contribution of such literature (e.g. Ahlquist and Mosley, 2020; Baumann-Pauly et al., 2015; Haar and Keune, 2014; Huq and Stevenson, 2018; Huq et al., 2016; 2014; Su, 2013; Taplin, 2014; Wigley et al., 212) is on the people and social aspect of sustainability. Literature also indicates uncoordinated recommendations for the industry to reduce its environmental impact except for the Ellen MacArthur Foundation (2019) and the EU (2020) reports on the circular economy for the textile industry. Nonetheless, such consultancy literature is focused on the meso level and post-consumer phase that does not help the supply chain much in demonstrating what needs to be done in different tiers of the supply chain and how.

Most of the previous review papers demonstrate CE practices covering redesign, reduce, reuse, recycle, remanufacturer, repair at a macro-analytical level; some have identified differences between a sustainable supply chain and a CE (Genovese et al., 2017). Only a small number have focused on CE practices and its opportunities and challenges when implementing a comprehensive CE in manufacturing industries (e.g., Lieder and Rashid, 2016). Through a systematic literature review Jia et al. (2020), identify drivers, challenges, practices, and indicators of sustainable performance when applying a circular economy in the textile and apparel industry and proposes a conceptual model that illustrates the relationship between them. They also highlight challenges in circular economy implementation and provides some suggestions for managers in the textile and apparel industry. Such an approach was also proposed by Franco (2017). Hvass and Pedersen (2019) also propose CE models for fashion brands, while Kumar and Suganya (2019) advise for prolonging the lifecycle of textile products earlier.

Prior works report a relationship between CE and environmental sustainability, whereas very few articles analyse the relationship between social sustainability and CE (Dey et al., 2019). Similarly, studies have investigated what technology is suitable for implementing waste management, resource optimisation and achieving energy efficiency—however, research on the impact of adopting specific technology on CE and sustainability performance in TC industry is scant. Dey et al. (2020) argue that organisations require recirculation of resources and energy, minimisation of resource consumption, recovery of value from waste (i.e. reuse, reduce and recycle) and a multi-level approach. We found that the impact of organisational aspects (e.g. organisational structure, processes, leadership roles, employee commitment, cultural change, level awareness, etc.), which also play a significant role for CE implementation in TC industry, is ignored.

As CE calls for organisational transformation for achieving sustainability (appropriate balance among economic, environmental and social aspects), a holistic framework that enables an organisation to follow a step-by-step approach to adopt CE is desired. The framework must also contain a diagnostic step to assess the current performance of supply chain circularity along with various issues and challenges and opportunities in line with desired performance targets. The involvement of the state as a regulator, NGOs as pressure groups for social and economic wellbeing and trade bodies as the industry lobby power is undeniable in the evolving circularity practice. Therefore, we have included government, NGOs and meso level organisations (e.g. trade bodies, unions) to develop a more holistic approach.

This research bridges the above knowledge gaps using empirical research within the TC industry in three emerging economies (Bangladesh, India and Vietnam) through revealing the current state of circularity of TC industry supply chains, challenges and opportunities and their effect on sustainability performance, and strategies, resources and action plans that are needed to implement CE successfully.

3. Methodology

Our research questions drive the methodological choice, and we adopt a mixed-method approach that combines statistical analysis of survey data, content analysis of the survey comments and focus group (Creswell and Clark, 2011). The proposed methodological framework (Figure 1) consists of the following steps to address the RQs.:

Step 1- the constructs and sub-constructs for CE and sustainability performance specific to the TC industry is derived from the literature review and presented in Table 2. We develop a few research hypotheses in line with the research questions to reveal correlations among the constructs.

Step 2- a questionnaire survey (Appendix 1) in line with the hypotheses and proposed framework is developed in this stage. The survey is developed based on the indicators outlined in the existing CE research (Table 2). The content validity of the survey questions is based on the validity of our construct and sub-constructs determined from literature (Bryman, 2012). The arrangement of the survey question is determined by the sequence of the CE practice-drivers-performance model.

Figure 1 about here

Step 3- primary data is collected through an interviewer-administered survey instrument from 114 TC manufacturing firms across Bangladesh, India and Vietnam. Bangladesh and Vietnam are respective the third and fourth-largest manufacturer of clothing, and India is the third largest manufacturer of textile products (UN Comtrade, 2019). We focused on business owners and managing directors since the implementation of a business model will generally depend on them. Employees lower in the hierarchy do not have such decision-making powers in the TC industry. The demography of our sample is presented in Table 3.

Table 2 about here

Therefore, a chain referral sampling method is adopted (Hafner-Burton et al., 2012; Heckathorn, 2011), which allowed strategic access to several networks of the TC industry elites. Although resource-intensive [our interviewer-administered study lasted approximately two years between 2017-2019] such referral ensured good response rates (i.e. Bangladesh, 63%; India, 54% and Vietnam, 48 %) captured the nuances and the deeper meanings of the issues (Saunders et al., 2012). Completing the survey in-person also allowed respondents to express their comments in detail and avoid research fatigue (Harvey, 2010). The multi-country survey helped us to observe any country specific factor that might affect the adoption of the CE.

Table 3 about here

Step 4- the survey responses were analysed to estimate the relationship of the variables within the analytical model using the STATA software. We created composite variables using a weighted average method with the indicators in our survey. As determined by existing literature, equal weights are assigned to each indicator. Our statistical method focused on the causal inferences among variables to address the RQ1 and RQ2. We use regression analysis to distinguish actual causality from spurious correlations. In that fashion, the results are based on a 'theory-driven' model since there is a relationship among the variables under examination (Herbert, 1977). There is relatively limited literature where causalities between circular economy and sustainability are not greatly explored since it is an emerging concept in the academic debate. Therefore, we also employ the 'reverse' regressions, where the previous dependent variables are now independent and vice versa. Such reverse regression also indicates if there is a bi-directional relationship between the constructs of the circular economy and sustainability. For robustness, the WLS estimator is applied to deal with possible heteroscedasticity and multi-collinearity issues in the data. Although OLS is generally robust, it can produce high standard errors when the homogeneity of variance assumption is violated. Weighted least squares (WLS) is a generalisation of OLS and includes an option for weighting variables with its variance to reduce the effects of heteroscedasticity. This produces standard errors of the coefficients that are smaller for WLS compared to OLS. In this paper, we provide both methods and their results for robustness and comparison. However, we run analyse in stages due to the way the three sustainability variables and the CE variables are constructed. We used the Breusch–Pagan and VIF tests to detect heteroscedasticity and multi-collinearity.

Step 5- We applied the content analysis of the qualitative data gathered from the interviewer-administered survey to address the RQ3. Our content analysis is an effective method to decipher patterns and deeper meaning to the survey responses (Cho and Lee, 2014) and helped deriving strategies, resources and action plan for adopting CE. The indicators/codes in Table 2 is used to code and analyse the qualitative data gathered from our survey instrument. A four-stage coding method (de-contextualisation, re-contextualisation, categorisation, and compilation) to perform the latent analysis of the text data was applied (Bengtsson, 2016). We captured the underlying meanings of the text data using our latent analysis as oppose to the manifest analysis of the content in which the researcher only presents what is most visible and apparent. The latent analysis helped us to develop themes in order to recommend strategy, resources and action plan. We used the NVivo software for our content analysis of our text data.

Table 4 about here

Finally, in step 6, the focus group is undertaken with the involvement of 25 representatives of TC industry. The demography of focus group attendees is outlined in table 4. Our participants are from different functional areas of the TC industry to facilitate a cross-disciplinary intervention in relation to CE influenced sustainability. Van Fan et al. (2019) have recommended such a cross-disciplinary approach earlier. The focus group protocol is attached in the appendix 2.

4. Conceptual Model and hypotheses development

We develop several hypotheses relating the CE fields of action (take, make, distribute, use, recover) with sustainability (economic, environmental, and social) performance in order to address the RQ1 and RQ2.

Economic performance dominates over the environmental and social performance in sourcing decisions for TC firms (Su, 2013). Supplier selection is generally governed by time, cost, and quality factors. However, due to buyers' and regulatory requirements TC firms are adopting environmental and social criteria into consideration for strategic sourcing recently (Dey et al., 2015; Gupta and Barua, 2017; Ho et al., 2011; Scott et al., 2015). Besides, TC firms generally opt for bulk procurement for scale economy and government incentive on strategic raw material (e.g. cotton in this case). However, in doing so, they end up with higher raw material inventory and perform poorly in sustainability (Lee, 2008). Certification from the International Organization for Standardization (ISO) is also becoming a mandatory criterion for volume buyers to award manufacturing contracts to manufacturers (Malesios et al., 2018).

Furthermore, green procurement (e.g. regenerative materials) is becoming popular globally, as identified in recent studies (Blome et al., 2014; Testa et al., 2016; Kumar et al., 2019). Moreover, local sourcing can be environmentally and social-friendly, although not efficient. Therefore, the relationship between take and sustainability performance can reveal the current state of CE practices within the TC industry. Accordingly, the first hypothesis is formed:

H1. Activities of take field of action such as materials and source selection and inbound transportation and storage are positively correlated to (1a) economic performance; (1b) environmental performance; and (1c) social performance.

TC firms can also become more sustainable by having eco-design, lean practices, energy efficiency, and access to renewable energy. Sustainability can also be enhanced with social well-being and equality in an industry in which racing to the bottom has been the norm for decades. There are a plethora of studies on social wellbeing, environmental performance and economic performance and their inter-relationship with varying and inconclusive outcomes (Asif and Searcy, 2014; Morioka and de Carvalho, 2016). De et al. (2018) and Tseng et al. (2018) contradicted with this, as they did not find any direct relationship between eco-design and lean practices with higher economic performance. Support for causal relationship running through social well-being and economic performance and environmental performance is even rare (Tseng et al., 2018). Cagno and Trianni (2013) and Dey et al. (2019) found that lean practices and energy efficiency measures help achieve both economic and environmental they are capital intensive in such a way that many businesses will not be able to afford them without subsidies. However, the dominant view is that there is a bi-directional relationship between environmental and economic performances as most green technology and practice are designed to save cost in the long term (Liu et al., 2017; Tseng et al., 2016). Nonetheless, we argue that environment-friendly TC firms are likely to have satisfied employees with higher economic performance (Dey et al., 2019; 2020). Therefore, we hypothesise:

H2. Activities of make field of action such as lean practice, eco-design, lower energy consumption, use of renewable energy, social wellbeing and equality are positively correlated to (2a) economic performance; (2b) environmental performance; and (2c) social performance.

Distribute as one of the CE fields of actions could also positively influence sustainability. Optimised green logistics can increase: (i) economic sustainability by delivering profitability through customers' satisfaction as a result of better lead time (Kumar et al., 2019) and efficiency (Perotti et al., 2012); environmental sustainability by reducing the carbon footprint (Jumadi and Zailani, 2010; Marchet et al., 2014); and social sustainability by increased CSR activities (Huq and Stevenson, 2014; 2018; Huq and Klassen, 2016; Piecyk and Björklund, 2015). TC firms are in great need for efficient and eco-friendly logistical solutions (Rossi et al., 2013) due to continually shrinking lead-time to satisfy the next-delivery demands for fashion products. Third-party logistics have also become popular, which bring efficiency along with environmentally friendly practices (Chen et al. 2011). Accordingly, H3 is proposed.

H3. Activities of distribute field of action such as outbound storage and transportation are positively correlated to (3a) economic performance; (3b) environmental performance; and (3c) social performance.

Use in CE field action helps to extend products' life through active after-sales service, repair, and reuse. There is a social movement to extend the life span of clothing products due to the negative environmental effect of unused and clothing items. Such environmental issue is further exacerbated by the shrinkage of the numbers of times a clothing item is worn in recent years. However, the economic outcome of extended product life on TC firms is yet untested. Studies conducted scoping other industries carbon offsetting activities often produced ambiguous results. For example, Zhang et al., (2015) suggested extension of product life helped achieve efficiency by engaging customers from different stages of consumptions. Fisher et al. (2009) assess carbon offsetting from a macro-social point of view as the prospect of a carbon-neutral society is ideal. However, only Laari et al. (2016) could evidence competitiveness achieved from GHG reduction when consumer group are concerned about the level of emission. Therefore, we propose:

H4. Activities of the use field of action such as carbon offsetting, after-sales service, repair, reuse and CSR are positively correlated to (4a) economic performance; (4b) environmental performance; and (4c) social performance.

Similar to the other fields of action, studies on recover also produced mixed outcomes. Bernon et al. (2018) rejected economic gains from reverse logistics and recycling, particularly for small and medium-sized businesses. In contrast, Eltayeb et al. (2017) and Sarkis et al. (2010) found a positive correlation between waste management and sustainability, including economic performance. However, Agarwal and Singh (2019) call for an in-depth analysis using the triple bottom line approach. So, the following hypothesis is introduced:

H5. Activities of recover field of action such as recycle and reverse logistics are positively correlated to (5a) economic performance; (5b) environmental performance; and (5c) social performance.

Unlike the ambiguity and mixed outcomes of the CE impact studies on sustainability, scholars unequivocally agreed on internal and external issues that hinder CE implementation. The lack of, customers' support, access to technology, institutional support, professionalism in environmental management and above all lack of financial support are identified as some of the external factors that disqualify businesses from adopting the CE model (Prieto-Sandoval et al., 2018; Ormazabal et al., 2016, Rizos et al., 2016). On the other hand, the lack of information system, technical resources, financial resources and management commitment are a few challenges endogenous to firms (Dey et al., 2020; 2019; 2015; Ritzén and Sandström, 2017). Therefore, we propose the following hypothesis to test if these external and internal factors affect the TC manufacturing firms in a similar way as other industries:

$H_{6.}$ External challenges hinder the adaptation, and internal challenges hinder the implementation of the CE business model in TC manufacturing firms.

Previous studies have successfully identified that growth (De et al., 2020), productivity (Dey et al., 2019; Malesios et al., 2018), reputation (Del Río, 2010), cost reduction (Ritzén and Sandström, 2017), emission reduction (Ellen MacArthur Foundation, 2019) and sustainability (Malesios et al., 2018; Moore and Manring, 2009), Social well-being (Dey et al., 2020) positively influence firms' propensity and intensity to adopt and implement the CE business model. Therefore, we propose the following hypothesis to test if such factors similarly affect TC manufacturing firms:

$H_{7.}$ Opportunities enable the implementation of the CE business model in TC manufacturing firms.

Nonetheless, Dey et al. (2020) and Jia et al. (2020) suggested few requirements such as smart regulation promote CE adoption. Moderate level of organisational slack, resource and facility sharing and publicity are also required for successful CE implementation. Accordingly, we hypothesise:

H8. Firms have macro and meso level requirements to successfully utilise the opportunities to offset the challenges to CE fields of action.

Hypothesis H1a to H5c are related to the RQ1, whereas H6 to H8 are related to the RQ2. As mentioned earlier, the content analysis addressed the RQ3, and the findings are validated through the focus group. The conceptual model relating the CE field of actions with the TC industry's sustainability performance is presented in Figure 2.

Figure 2 about here

5. Analytical Model and Results

Our analytical model for the statistical analysis of the scaled survey data takes the below forms:

$$\text{Sustainability performance} = \beta_0 + \beta_1\,\text{CE practice} + \beta_2\,\text{Growth} + \beta_3\,\text{Compliance} + \beta_4\,\text{size} + \beta_5\,\text{Product} + \beta_6\,\text{Country} + \varepsilon \text{ ----------(i)}$$

Where sustainability performance denotes the economic, environmental and social performance, the CE practice denotes the circular economy fields of action (take, make, distribute, use and recover). Growth, compliance, size and product are firms specific control variables, whereas the country variable captures any country specific factors related to sustainability and circular economy. The ε refers to the stochastic error term.

To assess the implementation challenges, opportunities and viability for the overall CE, we first analyse the circular economy from an aggregated concept. The aggregation is conducted following a weighted average method mentioned earlier, and the model is presented here:

$$\text{CE practice} = \beta_0 + \beta 1\,\text{Challenges} + \beta 2\,\text{Opportunities} + \beta 3\,\text{Econ. Sustainability} + \beta 4\,\text{size} + \beta 5\,\text{Product} + \beta 6\,\text{Country} + \varepsilon \text{ --------(ii)}$$

However, to specifically identify how the five fields of action are affected by the factors mentioned above, we run our model on the disaggregated data.

The following paragraphs describe the relationship of the variables within the model, whether those relationships are statistically significant; and whether some independent variables are more reliable predictors of the dependent variables. Table 5 and 6 contains the results using the WLS estimator, and Table 7 shows the list of previous studies that corresponds and contradicts with our findings and the outcomes of hypotheses. We have included the descriptive statistics, fitness of the model and the OLS results in Appendix 3a-c.

The effects of the CE fields of action on the TC industry's sustainability (RQ1)

To assess the impact of the CE business model on the sustainability of the TC industry, we regressed the economic, social and environmental sustainability variables with the CE field of actions, i.e. take, make, distribute, use and recover. Table 5 presents the results for the RQ1.

Take is significant for all the sustainability dimension (i.e. economic, 0.97; environmental, 0.99; and social, -0.22). Although our finding corresponds to previous studies of Gupta and Barua (2017) and Su (2013), the negative impact of take on social-sustainability requires attention. The TC companies in our sample have hardly any authority to decide the specifications of materials. The materials and source selection criteria are wholly determined by the buyer that takes the cost and environmental footprint as priorities. Therefore, buyers need to ensure that materials selection, source selection, inbound storage and transportation become more socially sustainable. Buyers may include manufacturers input in the procurement process in order to develop greater sustainability of the entire supply chain (Scott et al., 2015).

Table 5 about here

Make is negatively significant for the economic (-1.46) but non-significant for the social and environmental. The finding is seemingly counter-intuitive since this is the only field of action of the CE business model that generates revenue for the suppliers and create a livelihood for the employed workforce. However, our results correspond to the earlier findings of De et al. (2020) and Tseng et al. (2018). Activities within the make field, e.g. eco-design, lean practices, reduced energy consumption, use of renewable energy, employee wellbeing and equality, are supposed to improve the sustainability performance. Our respondents may felt that their manufacturing process is as environmentally friendly as it could be. Most large businesses in our sample have already conducted significant modifications in reducing carbon footprint within the environmental constraint they operate. However, such improvements came at a high cost, which reduces the short-term profitability for manufacturers and thus negatively affected economic sustainability.

Distribute is significant for the economic (0.08), social (-0.26) and environmental (0.31) respectively. The positive correlation between distribute and economic sustainability corresponds to earlier studies of Kumar et al. (2019), Perotti et al. (2012) and Rossi et al. (2013), while the outcome of environmental sustainability corresponds to the works of Chen et al. (2011), Jumadi and Zailani (2010) and Marchet et al. (2014). The negative outcome of distribute on social sustainability is small in magnitude but significant as it discloses the social cost of outsourcing business function to third-party service providers for outbound storage and transportation. Our findings contradict to Huq and Klassen, (2016) and Piecyk and Björklund (2015), among others. Although such a core-competency based approach brings positive economic outcomes for firms, for employees, it may mean job loss and hence detrimental to social sustainability. This finding also warrants the GHG emission control responsibility to the third-party service providers.

Use is significant for economic (0.22) and environmental (-0.64), but non-significant for social sustainability. The economic benefit created by use contributes to the retailers' business operation more than suppliers'. Manufacturers in our sample, which are further upstream in the value chain, do not gain as much economically from the use action. It seems that our respondents only counted the end-user of clothing and textile for the use action disqualifying the B2B use. Such findings correspond to Laari et al. (2016), yet imply that manufacturers have lack of awareness on how after-sales service, repair, reuse, carbon offsetting and CSR investment at the B2B level could positively contribute to sustainability performance.

We find that recover is the only field of action that is positively significant across all sustainability construct (economic, 0.41; social, 0.29; and environmental, 0.74; p-value < 0.01.) unequivocally strengthening the necessity of recovery and recycling of the TC products to reduce its ecological footprint. Although previous studies (e.g. Bernon et al., 2018; Eltayeb et al., 2017; and Sarkis et al., 2010) produced mixed and often ambiguous results on the correlation between recover and sustainability, our findings solidify the positive correlation between recover activities (e.g. reverse logistics, recycling, and waste management) and sustainability. This also implies that the TC industry managers perceive that they are currently doing their best for the *recover* CE filed of action.

Among the control variables (growth, size, product and country), only the size and product variables show significance for economic, social and environmental sustainability. We determined size by the number of employees implies that the bigger size is favourable for economic (0.33) and social (0.46) sustainability as they generate larger revenue, have more resources to deploy and more resilient to absorb unforeseen shocks compared to small firms. However, environmental (-1.45) sustainability suffers due to employees' lack of awareness and skill to ensure the environment-friendly production process. Bernon et al. (2018) also suggested how small and medium-sized businesses miss out from sustainability gains due to resource shortage. Similarly, diverse and higher value-adding products positively influence economic (0.27), social (0.24) sustainability. Firms that only produce low value-adding products (e.g. T-shirts) may struggle to bear the cost of social sustainability due to very low per-unit value addition. However, higher valued adding requires more environmentally damaging (-0.45) manufacturing and distributing process. Such findings imply that the scale and scope, nature of complexities, resource requirements and social and environmental footprint of these goods need to be revisited. It also reiterates that the customer's perception regarding value needs to change from price, appearance and packaging of the TC products to the eco-friendly attributes.

The challenges, opportunities and requirements of adopting a circular economy in TC industry (RQ2)

We intend to determine what are the opportunities and challenges to the implementation of the CE fields of actions and what are firms' requirements to implement such business model. In terms of the implementation of the CE, we investigated the aggregated CE that combines all five fields of actions first. We also test the five fields of actions separately against the challenges, opportunities, and other endogenous and exogenous factors. Table 6 presents the results for the RQ2.

Table 6 about here

Challenges that include both internal (lack of information system, technical and financial resources and management commitment) and external (lack of economic, customer and government support and access to technology) factors have serious negative implication (-0.35) on both adaptation and implementation of the CE. Internal challenges such as firms' lack of financial, technological resources, know-how, and senior managements reluctance along with end user's indifference to the CE have a significant negative impact across the board except for make. The coefficients take (-1), distribute (-1.98), use (-0.87) and recover (-1.63) are all significant at 99% confidence level. Such finding corresponds with the existing studies of Rizos et al. (2016), Sehnem et al. (2019) and Tseng et al. (2018).

On the other hand, opportunities such as productivity, sustainability, cost reduction and better image of the firm are also significant (Dey et al., 2018; Malesios et al., 2018; Wigley et al., 2012). Firms, in our data sample, struggle to use opportunities such as increasing brand image, buyer preference and reduction of cost and resource utilisation due to implementation of environmental management practice effectively hence the adverse effect (CE, -0.75; distribute, -3.77). However, positive outcome (use, 0.54) indicates opportunities identified by previous studies (e.g. Preston, 2012; Prieto-Sandoval et al., 2018; Ritzén and Sandström, 2017) are similarly significant for the TC manufacturers.

Unexpectedly, requirements such as government policy that promotes and incentivise CE adoption and resource sharing do not show significance to the aggregated CE and it's filed of actions except for distribute (- 1.23) field of action. Such results reiterate the lack of knowledge and understanding of the CE business model across the board. Due to such limitations, respondents in our sample could not identify their requirements for a more sustainable future.

Our assessment suggests that the CE can only be implemented in firms that are economically sustainable (- 0.003). However, the impact is negative due to excessive focus on cost and efficiency in order to become financially viable. A firm that is economically sustainable will be able to, invest in green technology, become more environmentally friendly, lower its carbon footprint, offer better employment terms to its employees, and engage in the CSR activities if they shift their focus from cost and efficiency to sustainability performance.

Among the control variables, the significance of the product is reiterated here, which further strengthen the economic viability argument. Firms that operate within the composite product category have better means to implement the CE business model and perform better in sustainability since the entire production process (from raw materials to finished goods) takes place under one roof. Such a production process requires much less transportation and leave comparatively less carbon footprint in the distribution field of action. For them, the reuse, recovery, recycling, and reverse logistics activities are much easier compared to a production system that is spatially scattered.

The compliance variable produced the expected outcome for make (0.23). As stated earlier, our respondents mainly control the make field of action. Rigorous compliance procedure is implemented in most TC manufacturing firms in the aftermath of the Rana Plaza tragedy in 2013. As a result, significant improvement has taken place on social and environmental performance, which in turn improve the economic performance for manufacturers. Our findings correspond with previous studies such as Huq and Stevenson (2018) and Moazzem (2018). However, the negative outcome for CE (-0.01), take (-0.42), distribute (-0.93) and use (-0.49) implies that manufacturers incur additional compliance cost for acquiring compliance certificate.

The country variable shows quite strong positive significance for the CE (0.50) and very strong negative significance for the recover field (-3.05) of action implying that the sustainability attitude at the national level and incentives, regulations and impetus for sustainability provided by the state apparatus is needed. The value chain of the TC industry is dependent on low-cost manufacturing; therefore, production is concentrated in locations with an abundance of cheap labour. Countries with such abundance of cheap labour are generally least developed or developing where economic growth is prioritised over the social and environmental concerns. Therefore, the impetus for implementing the CE business model is usually low according to our analysis. However, it is undeniable that large scale reuse and recover by the end-user will have a significantly positive impact.

Table 7 about here

Strategies (RQ3a), resources (RQ3b) and action plan (RQ3c) to facilitate effective implementation of circular economy in the TC industry

We analysed the qualitative survey comments of the respondents using a content analysis method. Table 8 shows the findings of the content analysis. The strategies, resource requirements and action plans are presented in Table 9.

Table 8 about here

The analysis of the survey comments also provided us with insights on challenges and opportunities facing TC firms while adopting and implementing the CE business model. Triangulating the statistical and content analysis with existing literature, we propose strategies, resource requirements and action plan for the TC firms CE adoption and implementation. For example, we identified that there is a scope for aligning the environmental values between the suppliers-manufacturers-buyers (Table 8, take) from the content analysis. Our statistical analysis also reiterated the significance of embedding environmental value in material and source selection (Table 5). This finding also corresponds with previous works of Jia et al. (2020) and Franco (2017). Such environmental value-based supply chain will promote the use of regenerative and biodegradable raw materials and environment-friendly dying and washing. We further validated, enriched and refined our findings through a focus group of 25 practitioners. Considering these, collaborative strategies to comply with the regulatory framework, the experience of carbon offsetting activities and optimal sourcing are among the action plans that emerged from our analysis (Table 9). The focus group has been particularly useful in determining the responsible parties.

Table 9 about here

Our content analysis identified that retailers do not share their environmental sustainability management expertise with their suppliers. Therefore, we suggest that knowledge and skill base for environmental management, investment in environment-friendly manufacturing technologies, and skill training are strategies that can promote a circular economy in the TC industry. Connecting manufacturers with the users to design product for an effective manufacturing process to reduce design and fit faults related waste; and using renewable energy (not only energy-saving technologies) are also strategies for sustainability practice. Technological resources (e.g. body scanning and sew bot) for waste reduction in manufacturing and quality control process; and financial resources (e.g. investment in renewable energy) will be required to implement such strategies. Traditional training that generally focuses on the linear business model to gain economic efficiency will not be sufficient. Instead, CE based skill training will lower energy consumption, enhance resource efficiency, reduce and recycle waste and increase the use of renewable energy in the make field.

Our respondents have less control of the distribute, use and recover fields of action. However, implementation of logistic optimisation technology for more efficient use of vehicle capacity, selection of logistic service based on fleets' emission footprint beyond cost and reliability and optimisation approach in lead-time and vehicle space management are thought to have a more significant impact on reducing the environmental footprint in distribution.

Operators at the downstream of the TC supply chain need to take more initiatives to reduce the environmental impact at the use stage. Hvass and Pedersen (2019) presented such examples earlier. However, environmental practices at the upstream of the supply chain can be used for positive branding. Similarly, the government can enforce recovery practices at the meso level to improve recovery. It appears from our findings that a new waste management industry can emerge as a result of environment-friendly waste disposal practices in the TC industry. Our respondents suggested that having an in-house waste management facility is unviable due to scalability. However, state of the art waste management facilities can be developed and operated by government, private businesses or even by the collaboration of TC factory owners in industrial areas (e.g. Gazipur and Narayanganj, two satellite towns of Dhaka city in Bangladesh). Such marketisation of the recovery practices will provide enough economic incentive for greener waste management.

6. Discussion

This research demonstrates the current state of circular economy in TC industry, challenges and opportunities, and strategies, resources and action plans for implementing CE. The TC industry contributes to economic growth but affects the environment negatively due to its efficiency focused value chain, which emphasises on economic performance over environmental and social. However, our findings indicate that the CE has the potency to deliver sustainability in micro (enterprises), meso (regions), and macro (national) levels for the TC industry.

Analysing data gathered from 114 TC firms from three countries (Bangladesh, India and Vietnam), we find *recover* is the only CE field of action that positively contributes to all the three sustainability performances indicating the pressing need for the reduction of TC waste and increasing reuse and recycle. However, the other four CE fields of action (*take, make, distribute,* and *use*) contribute to at least two out of three sustainability performances (i.e. *take* –economic and environmental; *make* and *distribute* -economic and social; *use*- social and environmental). Our multi-country study also highlights that the CE contribution to sustainability performance varies with the firm sizes (employee number) and type of products. Additionally, effectiveness of CE implementation is likely to depend on current economic sustainability, product type, compliance, geographic location and company size (Wijethilake, 2017).

Our qualitative data and focus group, derives strategies, action plans, and resources that are required to implement CE within the TC industry. The processes for adopting CE is an integrated approach across the value chain that include global TC retailers, manufacturers, suppliers and end customers. Besides, investment and promotion of the training, educational facilities, technology and processes that positively affect social and environmental aspects beyond efficiency is necessary. Knowledge sharing by the buyers can also make a significant impact in this case. However, the cost of such training programmes can be a challenge for smaller manufacturers and suppliers. Therefore, government, charities, NGOs, development institutions (e.g. World Bank, UN, and ILO) can collaborate to facilitate such programmes. The TC manufacturing firms will be able to increase their sustainability by reducing employee turnover and workplace accident, and increasing CSR investment, employee wellbeing, eco-design, lean practices, renewable energy adoption, logistic optimisation and carbon offsetting drawing (Dey et al., 2020; Liu et al., 2017).

This study provides valuable empirical evidence on the positive linkages between the adoption of the CE fields of action and TC industry's sustainability performance. The conceptual framework (see Figure 2) and the questionnaire (Appendix 1) acts as a diagnostic tool for the TC manufacturing firms to assess the circularity of their supply chain, identifies challenges and opportunities, and suggests action plan for improvement. This enables effective decision-making process for CE implementation for individual TC firms, trade bodies and policymakers. The findings also support to enhance the sustainability performance of TC manufacturers in any geographical location.

This research identifies several issues and challenges facing the TC firms while implementing CE across their supply chains. It is intriguing to find that this was the first time most of our respondents familiarised themselves with the CE concept. The lack of awareness of industry practitioners is a concern in the effort to reduce the negative environmental impact of the supply side of the industry. There is also a lack of knowledge and managerial expertise in dealing with environmental issues. However, fundamental actions such as take: material and source selection; and make: renewable energy and social wellbeing are already in practice within their organisations. Buyers and regulatory bodies generally enforce the use of biodegradable materials, treatments, filtrations and disposal of waste. Yet the knowledge spill over to the manufacturers is rare. Besides, accounting for social and environmental return on investment, and the ability to capture social and ecological output data are areas that require significant improvements.

Additionally, the respondents indicated that they will undertake eco-design only if it is economically feasible due to excessive competition. They also perceived the implementation of the lean practice and switching to green energy are capital intensive with minimal short-term benefit and therefore require financial incentives (Bocken & Short, 2016; Perez-Batres et al., 2012). They proposed that policymakers should categories such practice implementation in a similar way as capital machinery installation so that loan terms are softer.

Our primary contribution is the identification of correlations between the five fields of CE actions with the three dimensions of sustainability. Such disaggregated findings will allow TC firms, trade bodies and policymakers to focus on the particular field of action pertinent to environmental sustainability in their endeavour to promote greener growth. The study reveals that the TC industry is not very familiar with the CE as a concept. However, they perform the fields of action sometimes voluntarily and often to comply with buyers and regulators demands. There is a commendable achievement in social sustainability performance across the regional scope. In terms of environmental sustainability, ETP based ecological protection has taken centre stage. Yet the CO2 and GHG based pollutions are untouched often due to lack of understanding and control over the various fields of action.

Although the above findings are specific to Bangladesh, India and Vietnam, we can promote these across the other TC manufacturing counties and other low-skill manufacturing industries because of the similarities in business practices and government policies. Our recommendations (Table 9) will be more appropriate for the first-tier suppliers directly working with the retailer since our data captured from such TC firms. However, TC manufacturers that are working at the second or third tier of the supply chain can also take our recommendations as a good practice that will help them to add more value and expedite the upward movement in the supply chain. Overall our findings, although geographically and sector-wise contextual, corresponds to influential studies in the field (Jia et al., 2020; Kristensen and Mosgaard, 2020; Saidani et al., 2019) thus broadly generalisable. Nonetheless, sampling, research methodology, and selection of statistical technique are limitations that may have affected our findings. To steer clear from any biased result, we compared and validated our findings with contemporary literature, and referred experts' views and opinions.

New research on the relationship between CE and sustainability may stem from our findings. As take and recover fields of action appeared to have strongly influenced the sustainability of the TC industry, a detailed work could be undertaken on the critical success factors (e.g. materials and source selection, recycle and reverse logistics) of these field of actions. On the other hand, investigating why make is the least contributing field of action for sustainability could be an interesting study. Besides, it is also undeniable that sustainability can only be achieved through upskilling the workforce and moving towards higher value-adding products. We found empirical support for upskilling from our survey data. Future research on upskilling and its potential contribution to CE and sustainability within the TC industry will also add significant value. Our data also indicate that the power distance between the global TC retailers and their manufacturers from the developing countries such as Bangladesh, India and Vietnam affects how one sustainability aspect is prioritised over another. This aspect is beyond our current scope of the study. However, future research can investigate the bargain power imbalance in a vertically integrated supply chain of TC industry and how such imbalance affects the CE business model adoption for sustainability.

7. CONCLUSION

There is a universal consensus that global warming must be contained within 1.5^0 C to tackle the unprecedented climate emergency facing the world (IPCC, n.d.). There is scope of using 100% recyclable materials from product design to packaging for end users in the TC industry. The upstream of the value chain, e.g. raw material sourcing and manufacturing still requires a lot of attention to become environmentally friendly. There is also a lack of knowledge and managerial expertise in dealing with environmental issues. A scope for creating a waste management industry to recycle TC industry waste in Bangladesh, India and Vietnam to provide economic incentive for recovery practice is evident. Such commercialisation of waste management has benefitted developed countries to manage recovery activities more effectively. The ability to capture social and ecological output data are the areas that require significant improvements so that social and environmental return on investment can be accounted for. Currently, most available incentives are for economic sustainability in all three countries within our investigative scope. Therefore, governments also need to incentivise the environmental and social sustainability of the TC industry.

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Tables

Table 1: CE implementation action points

Function	Action point
Take	1. Stop using toxic and non-sustainable materials. 2. Select raw material and supplier based on green image. 3. Use fully recoverable materials. 4. Ensure process and product transparency.
Make	5. Educate employees on sustainability issues. 6. Minimise the environmental impact by resource optimisation. 7. Use of sustainable energy sources. 8. Adopt eco-design and zero waste production processes.
Distribute	9. Optimise stock, routes, and space for both forward and reverse logistics. 10. Collaborate with stakeholders for commitment.
Use	11. Communicate green attributes, e.g. eco-labelling, zero waste certification, with customers and end-users. 12. Adopt green marketing strategy, market segmentation and product system services.
Recover	13. Implement effective and efficient reuse and recycle system

Source: Dey et al. (2020) and Prieto-Sandoval et al. (2018)

Table 2 Description of variables and indicators/codes

Category	Composite variables	Indicators/Codes	Sources
CE field of actions	Take	Materials selection	
		Source selection	
		Inbound storage	
		Inbound transportation	

Category	Composite variables	Indicators/Codes	Sources
	Make	Eco-design	Benachio et al.,2020; Dey et al. 2020; Dey et al. 2019; Dey et al. 2018; Farooque et al., 2019; Geissdoerfer et al. 2017; Katz-Gerro and Sintas, 2018; Kristensen and Mosgaard, 2020; Kumar et al. 2019; Malesios et al. 2018, Prieto-Sandoval et al., 2018; Saidani et al., 2019; Sassanelli et al., 2019; Unal et al.,2019; Zhu et al., 2010
		Lean practices	
		Energy consumption	
		Use of renewable energy	
		Social wellbeing and equality	
	Distribute	Outbound storage	
		Outbound transportation	
	Use	After sales service	
		Repair	
		Reuse	
		Carbon offsetting / corporate social responsibility	
	Recover	Recycle	
		Reverse logistics	
Sustainability performance	Economic performance	Productivity	Dey et al. 2020; Dey et al. 2019; Dey et al. 2018; Geissdoerfer et al. 2017; Katz-Gerro and Sintas, 2018; Kumar et al. 2019; Kristensen and Mosgaard, 2020; Malesios et al. 2018, Prieto-Sandoval et al., 2018; Sassanelli et al. 2019; Unal et al. 2019; Zhu et al. 2010;
		Turnover	
		Cost reduction	
		Business Growth	
	Environmental performance	Energy efficiency	
		Waste reduction	
		Resource efficiency	
	Social performance	Employer turnover	
		Accident reduction	
		Carbon offsetting/CSR investment	
External and internal issues	Challenges	Lack of financial support	Jia et al, 2020; Lahane et al., 2020; Ormazabal et al. 2016; Pieroni et al., 2019; Prieto-Sandoval et al., 2018; Preston, 2012 ; Rizos et al., 2016; ; Ritzen and Sandstrom, 2017; Rosa et al., 2019; Suárez-Eiroa et al., 2019; Van Fan et al., 2019.
		Lack of customers' support	
		Lack of technology	
		Lack of professional in environmental management	
		Information system	
		Management commitment	
External and internal issues	Opportunities	Increased image	Del Rio et al. 2016; De et al. 2019; Dey et al. 2020; Dey et al. 2019 a;b; Dey et al. 2018; Ellen MacArthur Foundation, 2015; Malesios et al. 2018; Moore and Manring, 2009; Pieroni et al., 2019; Preston, 2012; Rizos et al. 2016; Ritzen and Sandstrom, 2017; Salvador et al.2020
		Cost reduction	
		Business growth	
		Emission reduction	
		Productivity	
		Sustainability	
		Social wellbeing	

Category	Composite variables	Indicators/Codes	Sources
Success factors	Requirements	Public institutional support	Ormazabal et al. 2016; Pieroni et al., 2019; Prieto-Sandoval et al., 2018; Preston, 2012 ; Rizos et al., 2016; ; Ritzen and Sandstrom, 2017
		Technical and financial resources to experiment with environment management	
		PR on environment management	
		Resource sharing	

Table 3 Demography of the participating TC firms

Title	Number			
Type of employees	Bangladesh	India	Vietnam	Cumulative
Owner	14	4	10	28
Director of operations	7	9	3	19
Director of sales and marketing	7	6	2	15
Quality and compliance manager	9	4	4	17
Chief Merchandiser	6	7	4	17
Procurement manager	7	4	7	18
Total	50	34	30	114
Company size				
Small	13	9	3	25
Medium	27	18	13	58
Big	14	8	9	31
Total	54	35	25	114
Product type				
Composite	10	7	12	29
Knitting and Dying	10	4	12	26
Weaving	5	0	0	5
Textile	14	16	0	30
Garment	11	7	6	24
Total	50	34	30	114

Table 4 Demography of focus group participant.

Participant	Country of origin and number of attendees			
Type	Bangladesh	India	Vietnam	Cumulative
TC practitioner	2	1	2	5
Buyer	1	1	1	3

NGO	1	1	1	3
Trade union	1	0	1	2
Industry lobby	2	1	1	4
Compliance practitioner	1	0	1	2
Researchers	1	2	1	4
Policy maker	1	1	0	2
Cumulative	10	7	8	25

Table 5 : CE and Sustainability (VWLS)

		Economic sustainability	Social sustainability	Environmental sustainability
Take	Coef.	0.97***	-0.22***	0.99***
	Std.err[1].	*0.00*	*0.00*	*0.00*
Make	Coef.	-1.46***		
	Std.err.	*0.00*		
Distribute	Coef.	0.08***	-0.26***	0.31***
	Std.err.	*0.00*	*0.00*	*0.00*
Use	Coef.	0.22***		-0.641***
	Std.err.	*0.00*		*0.00*
Recover	Coef.	0.41***	0.29***	0.74***
	Std.err.	*0.00*	*0.00*	*0.00*
Size	Coef.	0.33***	0.46***	-1.45***
	Std.err.	*0.00*	*0.00*	*0.00*
Product	Coef.	0.27***	0.24***	-0.45***
	Std.err.	*0.00*	*0.00*	*0.00*
_Cons	Coef.	0.19	1.09	5.46
	Std.err.	*0.00*	*0.00*	*0.00*

Note: *** = p value < 0.01; **= p value < 0.05; *= p value < 0.10

Table 6 Challenges, opportunities and requirements to the CE fields of action (VWLS)

		CE	Take	Make	Distribute	Use	Recover
		67	41	36	63	50	38
Econ. sus	Coef.	-0.003***	-0.095***		1.35***	-0.11***	1.65***

[1] Standard error values are rounded up to decimal point. Non-rounded values are also available from authors.

	Std.err.[2]	0.00	0.00		0.00	0.00	0.00
Challenge	Coef.	-0.35***	-1***		-1.98***	--0.87***	-1.63***
	Std.err.	0.00	0.00		0.00	0.00	0.00
Opportunity	Coef.	-0.75***			-3.77***	0.54***	
	Std.err.	0.00			0.00	0.00	
Requirement	Coef.				-1.23***		
	Std.err.				0.00		
Product	Coef.	0.06***	0.57***	0 .178***	0.20***	0.26***	0.78***
	Std.err.	0.00	0.00	0.00	0.00	0.00	0.00
Compliance	Coef.	-0.01***	-0.42***	0.23***	-0.93***	-0.49***	
	Std.err.	0.00	0.00	0.00	0.00	0.00	
Country	Coef.	*0.50****					- 3.05***
	Std.err.	0.00					0.00
Size	Coef.	-0.01***		0.32***	-1.10***	-0.68	
	Std.err.	0.00		0.00	0.00	0.00	
_Cons		5.97***	4.88***	1.90	25.53***	6.39***	4.46
		0.00	0.00	0.00	0.00	0.00	0.00

Note: *** = *p value < 0.01; ** = p value < 0.05; * = p value < 0.10*

Table 7 Comparison with existing literature and support for hypotheses.

CE fields of action	Correlation	Sustainability performance	Corresponding literature	Contradicting literature	Hypo-theses	Hypotheses supported
Take	Positive	Economic	Dey et al. (2019); Engert and Baumgartner (2016); Gupta and Barua, (2017); Su (2013); Tseng et al. (2016; 2018)		H1a	Yes
	Negative	Environmental			H1b	No
	Positive	Social			H1c	Yes
Make	Negative	Economic	Calabrese et al. (2012); De et al. (2018); Egels-Zandén and Rosén (2015); Huq and Stevenson (2018); Huq et al. (2016; 2014) Kumar et al. (2019); Sehnem et al. (2019); Tseng et al. (2018).	Engert et al. (2016)	H2a	No
	No	Environmental			H2b	No
	No	Social			H2c	No
Di str	Positive	Economic			H3a	Yes

[2] Standard error values are rounded up to decimal point. Non-rounded values are also available from authors.

Issues	Relationship	CE/fields of action	Corresponding literature	Contradicting literature	Hypo-theses	Results of hypotheses
	Negative	Environmental	Chen et al. (2011); Jumadi and Zailani (2010); Kumar et al. (2019), Marchet et al. (2014); Perotti et al. (2012); Rossi et al. (2013).	Huq and Klassen, (2016); Kinnunen and Kaksonen (2019); Piecyk and Björklund (2015)	H3b	No
	Positive	Social			H3c	Yes
Use	Positive	Economic	Calabrese et al. (2012); Egels-Zandén and Rosén (2015); Laari et al. (2016).	Dey et al. (2019)	H4a	Yes
	No	Environmental			H4b	No
	Negative	Social			H4c	No
Recover	Positive	Economic	Engert and Baumgartner (2016); Hvass and Pedersen (2019); Joy et al. (2012); Tseng et al. (2016; 2018)	Bernon et al. (2018); Eltayeb et al. (2017); and Sarkis et al. (2010)	H5a	Yes
	Positive	Environmental			H5b	Yes
	Positive	Social			H5c	Yes
Challenges	Negative	Overall CE and Take, Distribute, Use, recover	Mukherjee (2015); Rizos et al. (2016), Sehnem et al. (2019); Taplin (2014); Tseng et al. (2018);		H6	No
	No	Make				
Opportunities	Positive	Use	Dey et al. (2019); Huq and Stevenson (2018); Huq et al. (2016 and 2014)); Hvass and Pedersen (2019); Joy et al. (2012)		H7	No
	Negative	Overall CE, Distribute				
	No	Take, Make, Recover				
Requirements	Negative	Distribute			H8	No
	No	Overall CE, Take, Make, Use Recover				

Table 8 Content analysis

CE field of actions	Findings
Take	TC suppliers have very little control over material selection as they follow buyer's material selection process.
	Suppliers are selected based on trust, cost and efficiency. Environmental compliance in the selection process only captures hazardous material treatment, water use and waste management. Compliance is enforced very strictly by the host country government as well on theses aspect. However, the CO2 or GHG emission are not included as environmental criteria for environmental compliance yet.

	Suppliers promote their compliance to get volume contracts, but due to the high cost of environmental compliance, such contracts are not often profitable.
Make	Firms treat their waste and bi-product using the ETP. The dying process discharged a large number of hazardous liquids that are treated in the in-house treatment facilities before releasing in the sewage system. However, there is no treatment facility for oil, lubricants and other fluids that are used to run machinery.
	There is a high fixed cost for environment and social compliance. Old factories had to go through modification, that cost around 15% of the set-up cost of new factories. However, new factories are built to comply with all criteria. Bangladesh has the only Platinum quality TC factory building in the world.
	All investment in technology is focused on production efficiency as the lead-time is shrinking fast. Hardly any investment is there from owners for environmental compliance except for the ETPs.
	There is minimal use of renewable energy. However, there has been a lot of institutional investment in LED lightings and other forms of energy saving.
	Finance is the biggest hurdle as a private investment cannot cover the cost of fully sustainable operation. There are soft loan facilities provided by a various international institution such as the World Bank. But, factories need to be already environmentally compliant to receive such loans. Non-compliant business struggles to survive because they do not get a manufacturing contract and only work as third-tier suppliers with a meagre profit margin. Shutting them down is not a good idea due to job losses. A support system must be there so that they can become compliant.
	Significant investment and improvement have been achieved by NGOs, World Bank, buyers, and government have invested along with firms in social sustainability.
Distribute	All inward and outward shipment are generally conducted by a third-party logistics company. The selection process is based on cost and efficiency.
Use	There is a cultural preference of extended use of materials and products due to the frugal saving orientation of the societies in developing countries. But, replacing is becoming popular as people are becoming economically affluent.
	There is no evidence of resource sharing although it may reduce cost and increase environmental sustainability
	There is also a lack of know-how and managerial expertise in dealing with environmental issues. Buyers do not necessarily share their knowledge and expertise in this field. Such knowledge sharing will be highly beneficial.
Recover	There is a vibrant recycle market for the machinery at the end of their life cycle. Yarn unwinding is becoming popular, but it is very labour and time-intensive using the available technology.
	Firms performs reverse logistics, but they are not aware of the concept.

Source: Authors' analysis of the survey comments.

Table 9 Strategies, responsible parties, resources and action plan for adopting CE in the TC industry

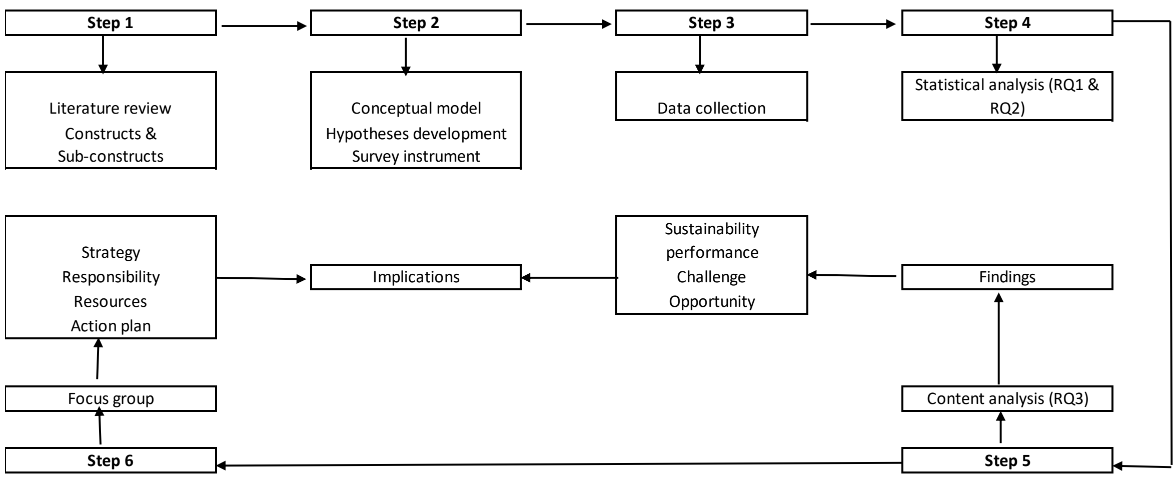
Fields of Actions	Strategies	Responsible party	Resources	Action plan
Take	Develop a buyer-manufacturer-material supplier relationship based on cost, quality and trust.	MNCs, manufacturers' suppliers, trade associations.	Regenerative and biodegradable raw materials.	Collaborative expertise to comply with regulatory framework.
				Communication with suppliers.

Fields of Actions	Strategies	Responsible party	Resources	Action plan
	Material selection based on quality-cost-environment criteria.		Environment friendly dying and washing products.	Experience of carbon offsetting activities.
				Procurement skill for standardisation.
				Ability to collaborate across the supply chain for optimal sourcing.
Make	Develop knowledge and skill base for environmental management.	Manufacturers, trade associations, and quality agencies.	Environmental education and skill-training facilities for eco-friendly manufacturing.	Servicing and maintenance skills to extend the life span of machineries.
	Invest on environment friendly manufacturing technology.			Expertise of waste reduction across supply chain through resource optimisation, energy reduction and continuous quality assurance.
	Provide skill training for employees' action sustainability practices.		Body scanning and sew bot technology for waste reduction in manufacturing and quality control process	CE based skill training could lower energy consumption, increasing use of renewable energy. Traditional trainings generally focus on the linear business model to gain economic efficiency.
	Use renewable energy not only energy saving technologies.			
	Connect manufacturer with user to design product for effective manufacturing process and reduced waste due to design and fit faults.		Investment in renewable energy sources.	Emphasise on waste reduction , and waste reduction
				Expertise in facility management and space optimisation.
				Project managing new product development
Distribute	Implement logistic optimisation technology for more efficient use of vehicle capacity.	Manufacturers, logistic services, quality agencies.	Know-how for logistic optimisation.	Management is committed to reduce carbon footprint in logistics along with cost reduction
	Select third party logistic service based on fleets' emission footprint beyond cost and reliability.		Fleet emission data.	Ability to design products with less packaging
	Adhere to country specific emission regulations.			Optimisation approach in lead-time and vehicle space management.
Use	Encourage product service system.	Retailers, trade bodies, consumer groups, green lobby.	Stake holder management capacity to communicate best practice in environmental protection	Ability to initiate meaningful dialogue with end users for ethical consumption.
	Use less and fully recyclable packaging.			
	Promote environmental and social measures to customers.		Ability to create a social movement of environment friendly ethical consumption.	
	Promote ethical consumption of clothing.			

Fields of Actions	Strategies	Responsible party	Resources	Action plan
Recover	Regulate and enforce recovery practice at the meso level.	Government and MNCs	Bureaucratic capacity to formulate and enforce regulation.	Commitment to a lean approach to implement reduce, reuse, and recycle philosophy.
	Train employees for practicing reduce, reuse, and recycle philosophy across the supply chain		Technology for recovery that is less resource-intensive and economically viable.	Develop waste management business.
	Marketization of the recovery practice for economic incentive.		Policy to create a profitable waste recycling market.	

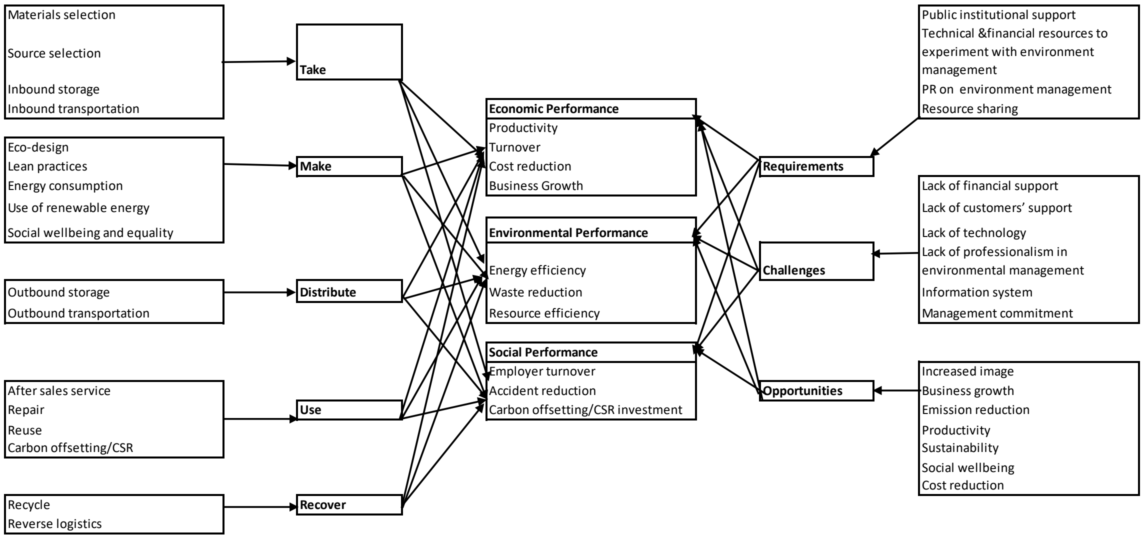
Source: Based on triangulation of statistical and content analysis of the survey data with existing literature (De et al., 2018; Dey et al., 2018; 2019; 2020; MacArthur, Zumwinkel, and Stuchtey, 2015; Malesios, Skouloudis, et al., 2018; Prieto-Sandoval, Ormazabal, et al., 2018; Rizos et al., 2016; Ritzén and Sandström, 2017); and focus group.

Figure 1 Proposed methodological framework



Source: Authors' elaboration of the methodological steps.

Figure 2 Conceptual model relating CE field of actions with the TC industry's sustainability performance



Source: Based on authors' review of literature (e.g. Dey et al. 2019; Franco, 2017; Geissdoerfer et al. 2017; Hvass and Pedersen 2019; Katz-Gerro and Sintas, 2018; Kumar et al. 2019; Kristensen and Mosgaard, 2020; Malesios et al. 2018, Prieto-Sandoval et al., 2018; Sassanelli et al. 2019; Unal et al. 2019; Zhu et al. 2010.)

Appendix1:

Questionnaire

Aim and Objectives: The overarching aim of this research is to facilitate the TC industry to achieve greater sustainability through a circular economy approach. The study has two dimensions:

- To reveal the state of circular economy practices and performance, issues and challenges, best practices, and constructs for circular economy adoption within the TC industry sector in Bangladesh.
- A process re-engineering framework will be used to eliminate barriers and derive the enablers for adopting circular economy in each participating TC business' supply chain across take, make, distribute, use and recover processes.

Method: In order to develop the understanding in the topic area and develop the re-engineering framework, a literature review is being conducted. To achieve the first dimension, the study embraces Delphi technique approaching the RMG sector experts using a questionnaire. To achieve the second dimension the study adopts a case study approach scoping the RMG sector in Bangladesh.

Circular Economy in TC Manufacturing Businesses

Part A: Organisation Demographics

1. Organisation Location: Country______________ City ________________________

2. No of employees:

100-500	501-1000	1001-5000	5000>
☐	☐	☐	☐

3. Position or Job Role (Pick the equivalent or the one most closest to your role):

Director Level	Managerial Level	Administrative	Others
☐	☐	☐	☐

4. Organisational Sector:

Knitting and Dying	Woven	Textile	Garment	Composite	Others
☐	☐	☐	☐	☐	☐

5. The % increase in Turnover (after tax) of year-on-year for the last three financial years (from 2015-16)

2016-17	0-10%	10-20%	20-30%	>30%
	☐	☐	☐	☐
2017-18	0-10%	10-20%	20-30%	>30%
	☐	☐	☐	☐
2018-19	0-10%	10-20%	20-30%	>30%
	☐	☐	☐	☐

6) Fixed Assets in (local currency):

A) less than 25 lakh [ ] B) 25-50 lakh [ ] C) 50 lakh-1 crore [ ]

D) 1-3 crore [ ] E) 3- 5 crore [ ] F) 5-10 crore [ ] G) More than 10 crore

8. Do you have Environmental Certifications (ISO 9001, ISO 14001, EMS, ISO 18001, OHSAS 18001, SA 8000, Other)?: Yes/No

   If Yes, what are these? ____

9. Did you receive any skill development training in Environmental Management? Yes/No

   If Yes, what are these? ____

Part B: Take – Make – Use –Distribute- Recover Cycle Activities of Circular Economy

10. Our buyers rate us according to our compliance with environmental regulation

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

11. Our buyers apply environmental purchasing criteria in the selection of suppliers

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

12. We have environmental criteria for reducing the consumption of raw materials, water, or energy usage in the production processes

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

13. We try to select biodegradable materials in our product design and production processes

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

14. If using non-biodegradable materials in our production, we aim to design them for reuse, recycle and remanufacture

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

☐ ☐ ☐ ☐ ☐

Remarks:

15. We considers environmental purchasing criteria while selecting our suppliers

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

16. We are aware of safe disposal options of our machineries and chemicals once they reaches end-of-life

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

17. We follow safe disposal options of our machineries and chemicals once they reaches end-of-life

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

18. Does the customer/policies ensure that we use treatments and filtrations to extend the use of industrial resources such as oils, acids, lubricants, etc.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

19. We use renewable energy to reduce impact on environment

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

20. Our superior product designs and maintenance policies aim to extend the product life and promotes extended materials and product use/reuse

Strongly disagree | Disagree | Neither agree nor disagree | Agree | Strongly agree

☐ ☐ ☐ ☐ ☐

Remarks:

21. We have robust plans (reverse logistics) to recover the products that our customers no longer use

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

22. We recycle the industrial material and waste we generate from our processes (chemicals, oils, packaging, plastics and any other non-biodegradable materials involved)

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

23. We consider third party logistics in the operations of the company

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

24. We consider effective production resource utilisation in the company

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

25. We consider effective production capacity utilization in the company

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

26. We consider effective inventory turnover in the company

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

27. We adopt social health and occupational hazard practice

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

☐	☐	☐	☐	☐

Remarks:

28. We adopted reverse logistics policy

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks:

29. We keep a record of the health and safety data within the enterprise

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

30. We have invested amount in Corporate Social Responsibility activities by the company in the last 5 years?

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

Part C: Opportunities and Barriers for adopting Circular Economy

31. There is lack of financial resources in our organisation

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

32. There is lack adequate technological[3] resources in our organisation

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

33. There is lack of know-how[4] on environmental management in our organisation

[3] Technological could be Enterprise Resource Planning (ERP), Radio Frequency Identification (RFID), Internet of Things (IoT), etc.
[4] Know-how could be implementing Value Stream Mapping, Lean Six Sigma, ISO Certifications, etc.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

34. There is lack of customer awareness and interest for impact on environment

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

35. There is lack of senior management support and interest for environment management

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

36. Reducing the impact on environment will increase the brand image of our organisation

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

37. Implementing environment management practices will reduce the costs

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

38. Implementing environment management practices will reduce pressure on resource availability

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

39. Government should promote policies, laws and regulations that reduce impact on environment

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

40. We require organisational slack such as human, technological and financial resources to experiment with environmental management

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

41. We need to share our resources with other organisations in the surrounding area to increase resource efficiency

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

42. We need to do more publicity promotion on our environmental management policies and practices

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

43. We get preference for practising the circular economy practices

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

44. Customers prefer us for practising the circular economy practices

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

☐ ☐ ☐ ☐ ☐

Remarks

45. Circular economy takes too much of time for implementation and financial considerations.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
☐	☐	☐	☐	☐

Remarks

Part D: Sustainability Performance

Economic Performance:

46. please tell the percentage improvement in the throughput achievement

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

47. Percentage reduction in production cost

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

Environmental Performance:

48. Percentage reduction cost in energy usage

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

49. Percentage reduction in waste cost reduction

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

Social Performance:

50. Percentage reduction in the absenteeism of the workers

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

51. Percentage reduction in the employee turnover

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

52. Percentage in job enhancement

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

53. Percentage of reduction in accidents

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

54. Percentage contribution in Corporate Social responsibility (CSR)

very low	low	medium	high	very high
☐	☐	☐	☐	☐

Remarks

Appendix 2: Focus group protocol:

Participants will be organised into 5 groups. Each group will pick up one of the five fields (take, make, distribute, use, and recover) of circular economy and discuss strategy, resources and action plan for sustainability performance (economic, environmental, and social).

Take

How to bring buyer-manufacturer-material supplier relationship based on cost, quality and trust?

What role firms, consortium (e.g., federation of TC business), customers (e.g., retails), and policymakers should play to bring them together.

What action plan would you suggest to ensure and enhance access to regenerative and biodegradable raw materials and environment-friendly dying and washing products?

Make

How to ensure knowledge spill over from buyers to the upstream of the value chain?

What are the primary resource requirements for “eco-design,” “lean practices,” “energy consumption,” “use of renewable sources of energy,” and “employee well-being and equality” within SMEs for achieving sustainability performance?

Is there any best practice within “Make” that you are aware of?

What action plan do you suggest in the above areas to enhance sustainability performance?

What role firms, consortium (e.g., federation of TC business), customers (e.g., retails), and policymakers should play to deliver sustainability in make.

Distribute

How to address emission footprint in “Outbound logistics (transportation and warehousing)” to achieve sustainability performance?

Is there any best practice within “Distribute” that you are aware of?

What action plan do you suggest in the above areas to enhance sustainability performance?

What role firms, consortium (e.g., federation of TC business), customers (e.g., retails), and policymakers should play to adopt circular economy framework?

Use

What are the major issues and challenges of “after sales services,” “reuse,” “repair,” and “corporate social responsibility,” within SMEs for achieving sustainability performance?

Is there any best practice within “Use” that you are aware of?

What innovation do you suggest in the above areas to enhance sustainability performance?

What role firms, consortium (e.g., federation of TC business), customers (e.g., retails), and policymakers should play to adopt circular economy framework?

Recover

Is marketization of the recovery practice possible in your country? If yes, how would marketization be possible? If no, what can be the alternative to marketization?

Is there any best practice within “Recover” that you are aware of?

What innovation do you suggest in the above areas to enhance sustainability performance?

What role firms, consortium (e.g., federation of TC business), customers (e.g., retails), and policymakers should play to adopt circular economy framework?

Appendix 3a Descriptive statistics

	Mean	Std. Dev	Cronbach's α	econsus	envirosus	socsus	take	use	recover	dist	make	barrier	enabler	requir-ement	growth	compliance	country	size	product
econsus	2.82	0.80	0.82	1.00															
envirosus	2.86	0.80	0.81	0.93	1.00														
socsus	2.67	0.74	0.81	0.60	0.71	1.00													
take	3.96	0.52	0.80	0.17	0.30	0.38	1.00												
use	3.76	0.75	0.80	0.31	0.44	0.57	0.66	1.00											
recover	2.90	0.87	0.83	0.54	0.50	0.59	0.06	0.30	1.00										
dist	3.16	1.41	0.84	-0.09	-0.14	-0.43	-0.10	0.00	-0.42	1.00									
make	4.20	0.46	0.81	-0.12	0.04	0.15	0.57	0.24	-0.28	-0.01	1.00								
barrier	1.88	0.85	0.82	0.07	-0.12	-0.11	-0.35	-0.42	0.02	-0.29	-0.47	1.00							
enabler	3.53	0.49	0.80	0.25	0.42	0.45	0.56	0.53	0.02	-0.11	0.66	-0.67	1.00						
requirement	3.94	0.56	0.83	0.36	0.39	0.27	0.30	0.36	0.37	-0.26	0.08	0.30	0.04	1.00					
growth	1.40	0.37	0.84	0.42	0.37	0.33	-0.23	-0.17	0.07	-0.16	-0.38	0.43	-0.15	-0.06	1.00				
compliance	2.33	0.98	0.83	-0.01	-0.09	-0.10	0.37	0.15	-0.08	0.12	0.36	-0.35	0.28	-0.37	-0.29	1.00			
country	2.04	0.75	0.82	0.05	0.20	0.05	0.28	0.22	-0.18	0.33	0.56	-0.78	0.56	-0.34	-0.41	0.42	1.00		
size	3.45	0.77	0.84	-0.06	0.17	0.26	0.04	0.07	-0.12	0.16	0.20	-0.27	0.08	0.11	0.18	-0.42	0.18	1.00	
product	3.29	1.31	0.83	0.05	0.06	0.33	0.27	0.13	0.10	-0.19	0.38	0.30	-0.03	0.24	0.02	0.02	-0.14	0.02	1.00

Appendix 3b*: CE and Sustainability (OLS)*

		Economic sustainability	Social sustainability	Environmental sustainability
Take	Coef.	0.29**	x	0.37***
	Std.err.	*0.15*	x	*0.14*
Make	Coef.	0.35*	0.23*	x
	Std.err.	0.20	*0.13*	x
Distribute	Coef.	0.16***	-0.14***	x
	Std.err.	*0.04*	*0.03*	x
Use	Coef.	x	0.45***	0.17**
	Std.err.	x	*0.06*	*0.09*
Recover	Coef.	0.59***	0.34***	0.48***
	Std.err.	*0.07*	*0.04*	*0.07*
Growth	Coef.	1.49***	0.86**	1.37***
	Std.err.	*0.15*	*0.09*	*0.14*
Compliance	Coef.	-0.18***	x	-0.25***
	Std.err.	*0.07*	x	*0.06*
Size	Coef.	-0.37***	0.15***	-0.15**
	Std.err.	*0.08*	*0.05*	*0.08*
Product	Coef.	x	0.09***	x
	Std.err.	x	*0.03*	x
Country	Coef.	0.35***	0.23***	0.53**
	Std.err.	*0.10*	*0.06*	*0.09*
_Cons	Coef.	-3.36	-2.67	-3.70
	Std.err.	*0.80*	*0.50*	*0.75*
R-squared		0.68	0.85	0.72
Adj R-squared		0.65	0.84	0.69
Mean *VIF*		2.27	2.27	2.27
Breusch–Pagan test		0.0049	0.0001	0.0036
Obs.	114			

Note: *** = p value < 0.01; **= p value < 0.05; *= p value < 0.10

Appendix 3c ***Challenges, opportunities and requirements to the CE fields of action (OLS)***

		CE	Take	Make	Distribute	Use	Recover
Econ. sus	Coef.	0.16***	-0.03	-0.23***	0.17	0.18***	0.71***
	Std.err.	0.03	0.04	0.02	0.16	0.07	0.14
Challenge	Coef.	-0.49***	-0.12	0.17***	-0.72**	-0.75***	-1.06***
	Std.err.	0.05	0.05	0.04	0.30	0.12	0.14
Opportunity	Coef.	-0.30***	0.36***	0.59***	-1.71***	0.10	-0.86***
	Std.err.	0.06	0.10	0.05	0.37	0.16	0.18
Requirement	Coef.	0.28***	0.41***	0.21***	-0.08	0.55***	0.33**
	Std.err.	0.05	0.08	0.04	0.26	0.11	0.13
Product	Coef.	0.09***	0.08***	0.11***	-0.05	0.13***	0.16***
	Std.err.	0.02	0.03	0.02	0.10	0.04	0.05
Compliance	Coef.	0.07**	0.23***	0.13***	0.06	0.06	-0.13
	Std.err.	0.03	0.05	0.02	0.17	0.07	0.08
Country	Coef.	-0.05	-0.07	0.27***	.050*	-0.33***	-0.60***
	Std.err.	0.05	0.08	0.04	0.27	0.11	0.13
Size	Coef.	-0.03	0.07	0.12***	0.13	-0.10	-0.35***
	Std.err.	0.04	0.06	0.03	0.20	0.08	0.10
_Cons		3.73***	0.43	-0.07	8.92***	2.53***	6.84
		0.39	0.60	0.31	2.11	0.88	1.03
R-squared		0.69	0.59	0.86	0.31	0.57	0.57
Adj R-squared		0.67	0.56	0.85	0.25	0.54	0.54
Mean VIF		2.35	2.35	2.35	2.35	2.35	2.35
Breusch–Pagan test		0.00	0.59	0.00	0.00	0.00	0.00

Note: *** = *p value < 0.01;* ** = *p value < 0.05;* * = *p value < 0.10*