### Implementing Circular Economy in the Textile and Clothing Industry

Krishnendu Saha | Prasanta Kumar Dey | Eleni Papagiannaki

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## 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 resources, along with management's reluctance and end users' 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, the host government's incentives, their buyers and above all, the conscience of the end-users. Finally, the study determines that the collaborative efforts, knowledge sharing in sustainability management across the value chain, and marketisation of 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

Correspondence Prasanta Kumar Dey, Aston Business School, Aston University, Aston Triangle, Birmingham B689LT, UK. Email: p.k.dey@aston.ac.uk

#### 1. Introduction

The textile and clothing (TC) industry is seen as the first step towards industrialisation (Brenton and Hoppe, 2007). It has enormously benefited many emerging economies by increasing their export revenue, creating jobs and improving their citizens' living standard. The TC industry's global trade was worth 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's empowerment (Ahmed et al., 2014).

Nonetheless, its negative environmental impact is also worrying. It is the second most polluting industry after oil (UN, 2019), with 10% of global greenhouse gas (GHG) emissions. Water pollution caused by dying effluent has polluted the river system around TC factories, resulting in the destruction of the aquatic ecosystem (Haque & 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 as posing a significant health risk for humans and animals alike (Haque & 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 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 marine life (BBC, 2015). Soil deterioration, deforestation, microfiber in seawater, and chemical additives are some other direct environmental costs of the industry. Besides, a conservative estimation suggests that \$3 billion worth of clothes and textile products end up in landfills 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 in 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 in the aftermath, workplace accidents persist, as the Bangladesh Institute of Labour Studies (BILS, 2017) reports that nine workers died and 206 (145 female) were injured due to factory hazards. The BILS also indicates unreported daily abuse of workers at 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 being brought mainly in developed countries so that the polluter bears the cost of sustainability. Besides, social sustainability issues caused by environmental degradation are 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 with 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 a 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 CE is a concept widely studied in China and the European Union, but in the inception stage in emerging economies (Katz-Gerro & 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 a more comprehensive study on the adoption of CE in the 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 the 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, and 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 a knowledge gap through a 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, the last two sections are for discussion and conclusion, respectively.

### 2. Literature Review

The CE 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 prompt reuse and recycling 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 at 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 & Iraldo, 2016; Ormazabal et al., 2016). Finally, policymakers facilitate the adoption of 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 costs. 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 & 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 to be synergistic among all the stakeholders across the supply chain, including policymakers.

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 the procurement department, the materials database, design and creativity, the human resource department; and competencies 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 competencies are production and project management. In the distribute field, traceability systems are 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 green marketing initiatives, including the consumer in product design, and materials; and competencies are green marketing initiatives, including the consumer in product design, and materials, and competences are the ability to design circular processes and products (Prieto-Sandoval et al., 2018).

## 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)

The studies of Katz-Gerro and Sintas (2019) demonstrate that suppliers (mainly SMEs) in various tiers of large businesses undertook waste minimisation, re-planning 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 businesses to replicate CE practice (Prieto-Sandoval et al., 2018). Therefore, three factors that are associated with adopting CE within the 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 & Keune, 2014; Huq & 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, remanufacture, and repair at a macro-analytical level; some have identified differences between a sustainable supply chain and CE (Genovese et al., 2017). Only a small number have focused on CE practices and their 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 propose a conceptual model that illustrates the relationship between them. They also highlight challenges in circular economy implementation and provide 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 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 the 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 the 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, 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 RQs 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.

Category	Composite variables	Indicators/Codes	Sources			
CE field of	Take	Materials selection				
actions		Source selection				
		Inbound storage				
		Inbound transportation	Benachio et al.,2020; Dey et al.			
			2020; Dey et al. 2019; Dey et al.			
	Make	Eco-design	2018; Farooque et al., 2019;			
		Lean practices	Geissdoerfer et al. 2017; Katz-			
		Energy consumption	Gerro and Sintas, 2018; Kristensen			
		Use of renewable energy	= 2010: Malasias at al. 2018. Prioto			
		Social wellbeing and equality	- Sandoval et al. 2018: Saidani et			
			- al 2019: Sassanelli et al 2019:			
	Distribute	Outbound storage	- Unal et al 2019 <sup>,</sup> 7hu et al 2010			
		Outbound transportation	-			
			_			
	Use	After sales service	_			
		Repair	-			
		Reuse	-			
		rosponsibility				
		responsibility	-			
	Recover	Recycle	_			
		Reverse logistics	_			
Sustainability	Economic	Productivity	Dey et al. 2020; Dey et al. 2019;			
performance	performance	Turnover	Dey et al. 2018; Geissdoerfer et al.			
		Cost reduction	2017; Katz-Gerro and Sintas, 2018;			
		Business Growth	Kumar et al. 2019; Kristensen and			
			Mosgaard, 2020; Malesios et al.			
	Environmental	Energy efficiency	2018, Prieto-Sandoval et al., 2018;			
	performance	Waste reduction	Sassanelli et al. 2019; Unal et al.			
		Resource efficiency	2019; 2nu et al. 2010; -			
			_			
	Social	Employer turnover	_			
	performance	Accident reduction	_			
		Carbon offsetting/CSR investment				
	Challenges	Lack of financial support	lia et al. 2020: Labane et al. 2020:			
	Chancinges	Lack of customers' support	Ormazabal et al. 2016: Pieroni et			
		Lack of technology	al. 2019: Prieto-Sandoval et al			
External and		Lack of professional in environmental	2018; Preston, 2012 ; Rizos et al			
internal issues		management	2016; ; Ritzen and Sandstrom,			

## Table 2 Description of variables and indicators/codes

Category	Composite variables	Indicators/Codes	Sources
			2017; Rosa et al., 2019; Suárez-
		Information system	Eiroa et al., 2019; Van Fan et al.,
		Management commitment	2019.
	Opportunities	Increased image	
	opportunities		Deviet al. 2020; Deviet al. 2019;
		Business growth	a;b; Dey et al. 2018; Ellen
External and		Emission reduction	MacArthur Foundation, 2015;
internal issues		Productivity	Malesios et al. 2018; Moore and
		Sustainability	Manring, 2009; Pieroni et al.,
		Social wellbeing	2019; Preston, 2012; Rizos et al.
			2016; Ritzen and Sandstrom, 2017; Salvador et al.2020
Success factors	Requirements	Public institutional support	Ormazabal et al. 2016; Pieroni et
		Technical and financial resources to	al., 2019; Prieto-Sandoval et al.,
		experiment with environment	2018; Preston, 2012 ; Rizos et al.,
		management	2016; ; Ritzen and Sandstrom,
		PR on environment management	2017
		Resource sharing	

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 the literature (Bryman, 2012). The arrangement of the survey question is determined by the sequence of the CE practice-drivers-performance model.

Figure 1 Proposed methodological framework



Source: Authors' elaboration of the methodological steps.

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 manufacturers 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.

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 resourceintensive [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.

Title		N	umber	
Type of employees	Bangladesh	India	Vietnam	Cumulative
Owner	14	4	10	28
Director of operations	7	9	3	19
Director of sales and	7	6	2	15
marketing				
Quality and	9	4	4	17
compliance manager				
Chief Merchandiser	6	7	4	17
Procurement	7	4	7	18
manager				
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 3 Demography of the participating TC firms

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 the 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 multicollinearity 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 analyses 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 intervieweradministered survey to address the RQ3. Our content analysis is an effective method to decipher patterns and deeper meaning to the survey responses (Cho & 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 opposed 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 a strategy, resources and an action plan. We used the NVivo software for our content analysis of our text data.

Table 4 Demography of focus group participant.

Participant	Country of origin and number of attendees			
Туре	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

Finally, in step 6, the focus group is undertaken with the involvement of 25 representatives of the 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 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 incentives on strategic raw materials (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 Organisation for Standardisation (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 socially 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 & Searcy, 2014; Morioka & 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 a causal relationship running through social well-being and economic performance and environmental performance is even rarer (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 goals; 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 (ii) efficiency (Perotti et al., 2012); environmental sustainability by reducing the carbon footprint (Jumadi and Zailani, 2010; Marchet et al., 2014); and (iii) social sustainability by increased CSR activities (Huq & Stevenson, 2014; 2018; Huq & Klassen, 2016; Piecyk & Björklund, 2015). TC firms are in great need of 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 has also become popular, which brings

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 the 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 effects of unused clothing items. Such environmental issue is further exacerbated by the shrinkage in the number 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 on 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 consumption. 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 provide evidence of competitiveness achieved from GHG reduction when consumer groups are concerned about the level of emissions. 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 the recover field of action, such as recycling and reverse logistics, are positively correlated to (5a) economic performance, (5b) environmental performance, and (5c) social performance.

## Figure 2 Conceptual model relating the 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.)

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, the 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 systems, technical resources, financial resources and management commitment are a few challenges endogenous to firms (Dey et al., 2020; 2019; 2015; Ritzén & 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 to other industries:

H<sub>6</sub>. 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 & Sandström, 2017), emission reduction (Ellen MacArthur Foundation, 2019) and sustainability (Malesios et al., 2018; Moore & 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<sub>7.</sub> Opportunities enable the implementation of the CE business model in TC manufacturing firms.

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

H<sub>8</sub>. 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 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.

#### 5. Analytical Model and Results

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

Sustainability performance =  $\beta_0 + \beta_1 CE$  practice +  $\beta_2 Growth + \beta_3 Compliance + \beta_4 size + \beta_5$ Product

roduct

+ 
$$\beta_6$$
 Country +  $\epsilon$  -----(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 firm-specific control variables, whereas the country variable captures any country specific factors related to sustainability and circular economy. The  $\varepsilon$  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:

CE practice =  $\beta_0 + \beta_1$  Challenges +  $\beta_2$  Opportunities +  $\beta_3$  Econ. Sustainability +  $\beta_4$  size +  $\beta_5$  Product +  $\beta_6$  Country +  $\epsilon$  ------(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. Tables 5 and 6 contain the results using the WLS estimator, and Table 7 shows the list of previous studies that correspond and contradict our findings and the outcomes of the hypotheses. We have included the descriptive statistics, fitness of the model and the OLS results in Appendix 3a-c.

## 5.1 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 RQ1.

*Take* is significant for all the sustainability dimensions (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 who 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).

		Economic sustainability	Social sustainability	Environmental sustainability
Take	Coef.	0.97***	-0.22***	0.99***
	Std.err <sup>1</sup> .	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

Table 5 : CE and Sustainability (VWLS)

<sup>1</sup> Standard error values are rounded up to decimal point. Non-rounded values are also available from authors.

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

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 creates 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 feel 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 their carbon footprint within the environmental constraints in which they operate. However, such improvements came at a high cost, which reduces the short-term profitability for manufacturers and thus negatively affects 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 functions to third-party service providers for outbound storage and transportation. Our findings contradict those of 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 is 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 that of the 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 textiles for the use action, disqualifying the B2B use. Such findings correspond to Laari et al. (2016), yet imply that manufacturers lack awareness of 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 constructs (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 their 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 imply 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, implying 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 are 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 an environment-friendly production process. Bernon et al. (2018) also suggested that small and medium-sized businesses miss out on sustainability gains due to resource shortage. Similarly, diverse and higher value-adding products positively influence economic (0.27) and 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 a 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.

# 5.2 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.

		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***
	Std.err. <sup>2</sup>	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

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

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

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 a 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 management's reluctance, along with end users' indifference to the CE, have a significant negative impact across the board, except for make. The coefficients take (-1), distribute (-

<sup>&</sup>lt;sup>2</sup> Standard error values are rounded up to decimal point. Non-rounded values are also available from authors.

1.98), use (-0.87) and recover (-1.63) are all significant at 99% confidence level. Such a 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 the 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 & Sandström, 2017) are similarly significant for the TC manufacturers.

Unexpectedly, requirements such as government policy that promotes and incentivises CE adoption and resource sharing do not show significance to the aggregated CE and its fields of action, except for the 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 CSR activities if it shifts its focus from cost and efficiency to sustainability performance.

Among the control variables, the significance of the product is reiterated here, which further strengthens 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 leaves a 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. A 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 improves the economic performance for manufacturers. Our findings correspond with those of previous studies by 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 costs for acquiring a 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 are 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 an abundance of cheap labour are generally the least developed or developing, where economic growth is prioritised over 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.

CE fields of action	Correlation	Sustainability performance	Corresponding literature	Contradicting literature	Hypo- theses	Hypotheses supported
	Positive	Economic	Dey et al. (2019); Engert and Baumgartner (2016); Gupta and		H1a	Yes
Take	Negative	Environmental	Barua, (2017); Su (2013); Tseng et al. (2016: 2018)		H1b	No
	Positive	Social			H1c	Yes
	Negative	Economic	Calabrese et al. (2012); De et al. (2018); Egels-Zandén and Rosén	Engert et al. (2016)	H2a	No
Make	No	Environmental	(2015); Huq and Stevenson (2018); Huq et al. (2016; 2014)		H2b	No
	No	Social	Kumar et al. (2019); Sehnem et al. (2019); Tseng et al. (2018).		H2c	No
	Positive	Economic	Chen et al. (2011); Jumadi and	Huq and Klassen,	НЗа	Yes
te			_ Zailani (2010); Kumar et al.	(2016); Kinnunen and		
stribu	Negative	Environmental	(2019), Marchet et al. (2014); Perotti et al. (2012); Rossi et al. (	Kaksonen (2019); Piecyk and Björklund	H3b	No
Dis	Positive	Social	2013).	(2015)	H3c	Yes

## Table 7 Comparison with existing literature and support for hypotheses.

	Positive	Economic	Calabrese et al. (2012); Egels- Zandén and Rosén (2015): Laari	Dey et al. (2019)	H4a	Yes
Use	No	Environmental	et al. (2016).		H4b	No
	Negative	Social			H4c	No
- L	Positive	Economic	Engert and Baumgartner (2016);	Bernon et al. (2018);	H5a	Yes
COVE	Positive	Environmental	Hvass and Pedersen (2019); Joy	Eltayeb et al. (2017);	H5b	Yes
Re	Positive	Social	2018)	2010)	H5c	Yes
lssu	Relationship	CE/fields of	Corresponding literature	Contradicting	Нуро-	Results of
es		action		literature	theses	hypotheses
	Negative	Overall CE and	Mukherjee (2015); Rizos et al.		H6	No
ges		Take, Distribute,	(2016), Sehnem et al. (2019);			
allen		Use, recover	Taplin (2014); Tseng et al. (2018);			
Ch	No	Make				
	Positive	Use	Dey et al. (2019); Huq and		H7	No
ties			Stevenson (2018); Huq et al.			
ini	Negative	Overall CF.	(2016 and 2014) ); Hvass and			
port		Distribute	Pedersen (2019); Joy et al. (2012)			
do	No	Take, Make,				
		Recover				
ents	Negative	Distribute			H8	No
em	No	Overall CE,				
quir		Take, Make,				
Rec		Use Recover				

# 5.3 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 Content analysis

CE field of	Findings			
actions				
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.*

The analysis of the survey comments also provided us with insights into the 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 an 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, and 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 an 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 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	MNCs, manufacturers' suppliers, trade associations.	Regenerative and biodegradable raw materials.	Collaborative expertise to comply with regulatory framework.
	based on cost, quality and trust.			Communication with suppliers.
	Material selection based on quality-cost-	-	Environment friendly dying and washing	Experience of carbon offsetting activities.
	environment criteria.		products.	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. Use renewable energy not only energy saving tochnologies	-	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 officiency.
	Connect manufacturer with user to design product for effective manufacturing process	-	Investment in renewable energy sources.	Emphasise on waste reduction , and waste reduction
	and reduced waste due to design and fit faults.			Expertise in facility management and space optimisation.
				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.

Fields of Actions	Strategies	Responsible party	Resources	Action plan			
Use	Encourage product service system.	Retailers, trade bodies, consumer _ groups, green lobby.	Stake holder management capacity to communicate best	Ability to initiate meaningful dialogue with end users for ethical consumption.			
	recyclable packaging.		practice in environmental protection				
Promote environmentalAand social measures toncustomers.ePromote ethicale		Ability to create a social movement of environment friendly	-				
Promote ethical consumption of clothing.			ethical consumption.				
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.

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 products 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 sewbot) for waste reduction in manufacturing and quality control processes, 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 manufacturing.

Our respondents have less control over the distribution, use and recovery 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 the circular economy in the 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 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 that recover is the only CE field of action that positively contributes to all three sustainability performances, indicating the pressing need for the reduction of TC waste and increasing reuse and recycling. 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, the 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 derive strategies, action plans, and resources that are required to implement CE within the TC industry. The process for adopting CE is an integrated approach across the value chain that includes 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, the government, charities, NGOs, and development institutions (e.g., the 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 accidents, 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 the TC industry's sustainability performance. The conceptual framework (see Figure 2) and the questionnaire (Appendix 1) act as a diagnostic tool for the TC manufacturing firms to assess the circularity of their supply chain, identify challenges and opportunities, and suggest an action plan for improvement. This enables an effective decision-making process for CE implementation for individual TC firms, trade bodies and policymakers. The findings also support enhancing 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 among 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 would undertake eco-design only if it was 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 and 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 a 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 countries 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 was 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, correspond 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 of any biased result, we compared and validated our findings with contemporary literature and referred to 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 making 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 bargaining power imbalance in a vertically integrated supply chain of the 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 °C to tackle the unprecedented climate emergency facing the world (IPCC, n.d.). There is scope for 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 benefited developed countries in managing recovery activities more effectively. The ability to capture social and ecological output data is 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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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

Pa	<b>rt A:</b> Organisatio	n Demographics				
1.	Organisation Lo	ocation: Country		City		
2.	No of employee	es:				
	100-500	501-1000	1001-5000	500	00>	
				Ε	2	
3.	Position or Job	Role (Pick the equival	lent or the one m	nost closest to	your role):	
	Director Level	Managerial Level	Administrativ	e Otł	ners	
				Γ	L	
4.	Organisational	Sector:				
	Knitting and	Woven	Textile	Garment	Composite	Others
5.	The % increase 2015-16)	in Turnover (after tax	() of year-on-yea	r for the last t	hree financial y	ears (from
	2016-17	0-10%	10-20%	20-3	30%	>30%
				C	C	
	2017-18	0-10%	10-20%	20-3	30%	>30%
				Γ	2	
	2018-19	0-10%	10-20%	20-3	30%	>30%
				Γ	J	
6)	Fixed Assets in (I	ocal currency):				
A)	less than 25 lal	<h[] 25-5<="" b)="" td=""><td>0 lakh []</td><td>C) 50 lakh-:</td><td>1 crore []</td><td></td></h[]>	0 lakh []	C) 50 lakh-:	1 crore []	
D)	1-3 crore [ ]	E) 3- 5 crore [ ]	F) 5-10 crore	[ ] G) More t	han 10 crore:	

8. Do you have Enviro SA 8000, Other)?: \	onmental Certific Yes/No	cations (ISO 9001, ISO 14	1001, EMS, ISO 1	18001, OHSAS 18001,							
If Yes, what are these?											
9. Did you receive an	y skill developm	ent training in Environm	ental Managem	ent? Yes/No							
If Yes, what are the	ese?										
Part B: Take – Make –	Use – Distribute	- Recover Cycle Activitie	s of Circular Eco	onomy							
10. Our buyers rate us	according to ou	r compliance with enviro	onmental regula	tion							
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree							
Remarks:											
11. Our buyers apply e	nvironmental pu	urchasing criteria in the s	selection of sup	pliers							
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree							
Remarks:											
12. We have environm usage in the produ	ental criteria for ction processes	r reducing the consumpt	ion of raw mate	erials, water, or energy							
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree							
□ Remarks:											
13. We try to select bio	odegradable ma	terials in our product de	sign and produc	tion processes							
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree							
□ Remarks:											
14. If using non-biodeg and remanufacture	gradable materia e	als in our production, we	aim to design t	hem for reuse, recycle							
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	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	Agree	Strongly agree								
Remarks:												
17. We follow safe disp	oosal options of	our machineries and ch	emicals once the	ey reaches end-of-life								
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree								
18. Does the customer industrial resource	/policies ensure s such as oils, ac	e that we use treatments cids, lubricants, etc.	and filtrations t	o extend the use of								
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree								
Remarks:												
19. We use renewable	energy to redu	ce impact on environme	nt									
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree								
Remarks:												
20. Our superior produ promotes extended	ict designs and i d materials and	maintenance policies ain product use/reuse	n to extend the p	product life and								
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree								

Remarks:							
21. We have robust pl use	ans (reverse logi	stics) to recover the prod	ucts that our c	ustomers no longer			
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree			
22. We recycle the inc packaging, plastics	dustrial material s and any other r	and waste we generate fr ion-biodegradable materi	om our proces als involved)	sses (chemicals, oils,			
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree			
Remarks:							
23. We consider third	party logistics in	the operations of the cor	npany				
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree			
□ Remarks:							
24. We consider effec	tive production r	resource utilisation in the	company				
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree			
Remarks:							
25. We consider effec	tive production o	capacity utilization in the o	company				
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree			
□ 26. We consider effec	□ tive inventory tu	rnover in the company					
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree			
□ Remarks:							
27. We adopt social he	ealth and occupa	tional hazard practice					
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree			

□ Remarks:				
28. We adopted re	everse logistics p	olicy		
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
Remarks:				
29. We keep a ree	cord of the healt	h and safety data within	the enterprise	
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
30. We have inve the last 5 year	sted amount in C s?	Corporate Social Respons	sibility activities	by the company in
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
Remarks				
Part C: Opportunities	and Barriers for	adopting Circular Econo	my	
31. There is lack o	f financial resour	ces in our organisation		
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
□ Remarks				
32. There is lack a	dequate technol	ogical <sup>3</sup> resources in our	organisation	
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
		nor disagree		
Remarks				

33. There is lack of know-how<sup>4</sup> on environmental management in our organisation

<sup>&</sup>lt;sup>3</sup> Technological could be Enterprise Resource Planning (ERP), Radio Frequency Identification (RFID), Internet of Things (IoT), etc.

<sup>&</sup>lt;sup>4</sup> Know-how could be implementing Value Stream Mapping, Lean Six Sigma, ISO Certifications, etc.

Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
Remarks 34. There is lack o	f customer awar	eness and interest for im	pact on environ	ment
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
35. There is lack o	f senior managei	ment support and intere	st for environme	ent management
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
Remarks				
36. Reducing the i	mpact on enviro	nment will increase the I	orand image of o	our organisation
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
Remarks				
37. Implementing	environment ma	anagement practices will	reduce the cost	S
Strongly disagree	Disagree	Neither agree	Agree	Strongly agree
Remarks				
38. Implementing availability	environment ma	anagement practices will	reduce pressure	e on resource
Strongly disagree	Disagree	Neither agree	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 o experiment v	organisational slack vith environmenta	such as human, techno I management	blogical and finar	ncial resources to
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
41. We need to s resource effic	share our resource ciency	s with other organisatic	ons in the surrou	nding area to increase
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
42. We need to o practices	do more publicity p	promotion on our enviro	onmental manag	ement policies and
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
43. We get prefe	rence for practisin	g the circular economy	practices	
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
44. Customers p	refer us for practis	ing the circular econom	y practices	
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

Remarks 45. Circular econ	omy takes too mu	ch of time for impleme	ntation and finar	ncial considerations.
Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Remarks				
Part D: Sustainability Economic Perfor 46. please tell th very low	Performance mance: e percentage impr low	ovement in the through medium	nput achievemer high □	it very high □
Remarks				
47. Percentage r very low □	eduction in produc low	ction cost medium	high □	very high
Remarks				
Environmental P	erformance:			
48. Percentage very low □ Remarks	reduction cost in e low □	nergy usage medium □	high □	very high
49. Percentage r very low □	eduction in waste low □	cost reduction medium	high □	very high
Remarks <b>Social Performar</b>	nce:			
50. Percentage very low	reduction in the ab low	osenteeism of the worke medium	ers high □	very high
Remarks				
51. Percentage r very low □	eduction in the em low	nployee turnover medium	high □	very high

Remarks

52. Percentage in job enhancement								
very low	low	medium	high	very high				
Remarks								
53. Percentage of	of reduction in ac	cidents						
very low	low	medium	high	very high				
Remarks								
54. Percentage o	contribution in Co	rporate Social responsi	bility (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**

		Std.	Cronbach's											requir-		comp			
	Mean	Dev	α	econsus	envirosus	socsus	take	use	recover	dist	make	barrier	enabler	ement	growth	liance	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	х	0.14	
Make	Coef.	0.35*	0.23*	х	
	Std.err.	0.20	0.13	х	
Distribute	Coef.	0.16***	-0.14***	х	
	Std.err.	0.04	0.03	x	
Use	Coef.	Х	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***	х	
	Std.err.	Х	0.03	х	
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

		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.	-	-0.12	0.17***	-0.72**	-0.75***	-1.06***
		0.49***					
	Std.err.	0.05	0.05	0.04	0.30	0.12	0.14
Opportunity	Coef.	-	0.36***	0.59***	-1.71***	0.10	-0.86***
		0.30***					
	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

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

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