Feasibility of the Circular Economy Model for Sri Lankan Industries: A Conceptual approach

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Abstract

Industries worldwide are fast adopting the circular economy production method due to the associated cost benefits and environmental friendly nature. Manufacturing with the circular economy method has proven to be effective and industries based on the traditional linear economic model are under pressure. The objective of this study is to assess the readiness of Sri Lankan industries to adopt the circular economy method. With the circular economy method, industries are expected to be more competitive and environmental friendly. Few cases of the Sri Lankan manufacturing sector are taken to identify the challenges and possibilities to move to circular economy method in production. This methodology involved selecting varied industry cases, collecting data through observations, stakeholder interviews, and document reviews, followed by a thematic analysis to discern patterns related to the circular economy model. The study focusses on the theory of the circular economy method followed by an empirical verification of the samples of the industry. Therefore, the study follows a conceptual approach to investigate the feasibility of the circular method in Sri Lanka. At the end, the study highlights its major findings.

Keywords: *Linear economy, Circular economy, Environment, Manufacturing*

1. Introduction

Industries around the world have been following a linear economic model for a long time. The linear economic model supply chain consists of providing raw material to production, conducting manufacturing processes, and eventually providing consumers with a finished product. After the finished product is consumed, what remains is the waste product. This is called an open production system (McDonough, *et.al*., 2010). The circular economy is the alternative for the open system of production because it is a closed system of production that reuses the waste thereby linking the consumer back with the producer. In this way manufacturing companies add more value to the commodity, conserve energy and thereby can make more profit. (McDonough & Braungart, 2002;Geng, *el at*., 2009; Xue, et al., 2010).

The circular economy is a transformative economic model that seeks to shift away from the traditional linear "take-make-dispose" paradigm, which relies on the extraction of finite resources, followed by their eventual disposal as waste. Instead, the circular economy promotes a closed-loop system, where products, materials, and resources are continually reused, remanufactured, and recycled, minimizing waste and environmental degradation (Geissdoerfer, *et al*., 2017). The core ethos of this approach is to design out waste and pollution, maintain products and materials in use for extended periods, and regenerate natural systems, ensuring long-term sustainability (Korhonen, *et al*., 2018).

The circular economy consists of three main pillars. The first pillar is no end-of-life products. That means that the product is reproduced using the waste of the original product. The second pillar is the continuous usages of the same commodities and material. The third pillar in fact derives from the second pillar. That is, restoration of natural systems because of the usage of same material and commodities (Ellen Macarthur Foundation, 2018). This process of reduce, reuse and recycle eliminates the environmental degradation associated with the linear economic model (Pearce & Turner, 1991), resulting in sustainable usage of natural resources, economic value, and technical properties of the product as well (Ketels & Protsiv, 2017).

Accordingly, the circular economy replaces the take-make-dispose approach of the linear economy model. For example, consider the situation of power generation based on renewable energy versus power generation using fossil fuel. In the case of renewable energy, which is closer to the circular economy method, it is more importance to the selection of material and product design that would encourage more innovative business models with minimum leakages (closed-loop economic circle).[1]

[1]There are many sub-sections of the circular economy, such as renewable energy; waste management; reuse; recycling and production; raw material and energy efficiency; sharing

It is evident that certain global brands are gradually moving towards the circular economy production method. Few examples worth noting are: (1) The partnership between Adidas and Parley in 2015 to manufacture ocean sneakers using the waste of deep-sea gill nets[2] (2) Nike Flyknit sneakers made from a new material that contains more than 50 percent recycled leather fibre or Flyleather (Ismael, 2019) (3) The clothing manufacturing process started by Arvin Goods that uses the lowest amount of clean water and synthetic dyes in the process that reduces the need for more clean water and synthetic dye (Remake, 2017).

Given the advantages of the circular economy, especially for emerging economies such as Sri Lanka, the objective of this study is to identify the feasibility of adopting the method into a selected manufacturing industries in Sri Lanka. The report focusses on the empirical and application aspects of current industry practices in Sri Lanka. The study expects to understand the issues and challenges to employ a circular economy model in Sri Lankan industries.

The next section of the study distinguishes between linear and circular economy. The section three focuses on the current industry practices in Sri Lanka to set the stage for analysis. The fourth section looks at the challenges to shift to a circular economy while highlighting a certain draw back associated in the circular economy method. In the end the study summarises main highlights of the discussion.

2. Linear vs. circular economy

Since Industrialization, the idea of circulating resource flow became a highly debatable concept. When societies started to be more conscious of the ecological degradation as a result of manufacturing activities, the emphasis on the circular economy has renewed. Governments were keen to promote new business startups with less adverse ecological effects when industrialization was spread throughout the world (Desrochers, 2002, 2004). However, the linear economic model continued to dominate the global industry because of its efficacy. The production technology, the way the resources are extracted, and the applicable legislature were more supportive towards a linear economic model. Therefore, the linear economic model allowed companies to generate higher profits. Environmental pollution, an essential by-product of the linear economic model, was severely neglected because wealth

economy, such as leasing and renting; environmental services, such as environmental engineering; water; and environmental protection (Ketels & Protsiv, 2017).

[2]Using gills nets to catch fish is prohibited in many countries. Every year large stocks of waste gills nets are confiscated as waste ocean plastics by regulatory authorities.

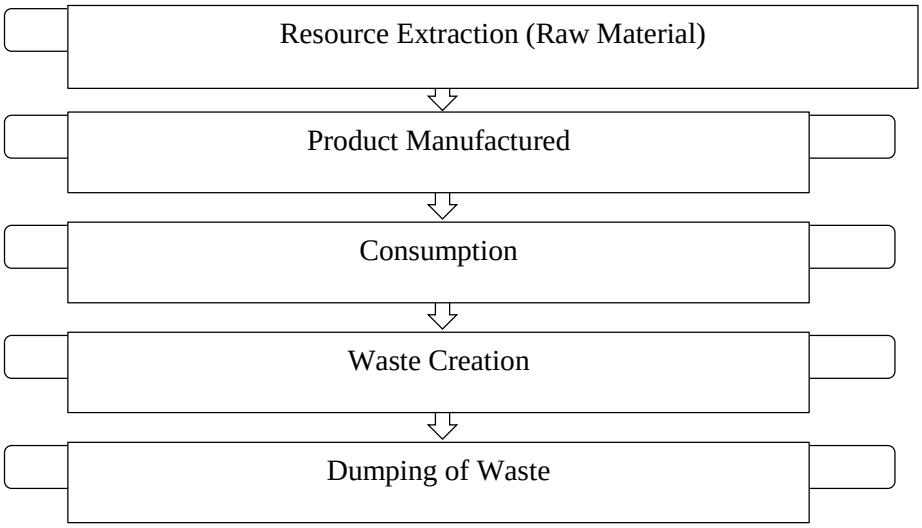
formation is in favour of individual businesses than the society at large (Ellen MacArthur Foundation, 2013; Upadhayay & Alqassimi, 2019).

Historically, the dominance of the linear "take-make-dispose" method, even in the face of emerging eco-friendly startups, can be attributed to a confluence of economic, technological, and political factors. Economically, the linear model was inherently attractive to industries because it was straightforward, relied on well-established supply chains, and often yielded immediate profits. The rapid industrialization of the 20th century favored models that could scale quickly and cater to ever-growing consumer demands, without necessarily accounting for long-term ecological consequences (Tukker, 2015). Technologically, innovations during the early phases of industrialization were largely tailored to support the linear economic model. The infrastructures for extraction, production, and distribution were more mature and received more R and D investments than their circular counterparts (Gregson, *et al.*, 2015).

Politically, the linear economic model often received implicit support from governments. During the initial phases of industrialization, the primary goal for many governments was economic growth and job creation. Policies and incentives were thus geared towards industries that promised immediate economic returns, even if they were resource-intensive and ecologically detrimental (Bocken, *et al.*, 2016). While some governments recognized the value of eco-friendly startups, the overarching political-economic structures, entrenched interests, and the urgency of short-term economic goals often overshadowed long-term sustainability considerations.

Most industries around the world are currently employing an extract-make-consume-and-return approach in production and consumption. This method is considered an open production system in which the value chain is organised, extracting and distributing production resources, carrying out the manufacturing processes and providing customers with a finished commodity for consumption. After consumption, the waste is disposed that ends the value chain (McDonough & Braungart, 2002; Geng, *et al.*, 2009; Xue, *et al.*, 2010). This is in fact the linear economic model discussed above (Frosch & Gallopoulos, 1989). Due to the increase in production to match ever-increasing consumption, the linear economic model is becoming unsustainable. The following diagram helps to understand the nature of the linear economic model.

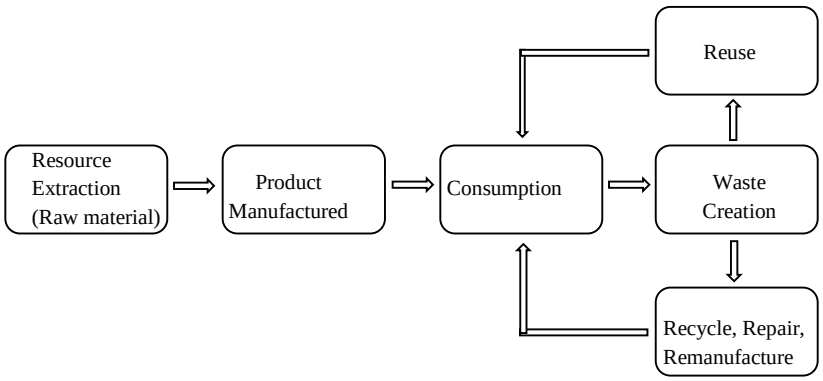
Figure 1-Linear economic model



Source: Upadhayay and Alqassimi, 2019

According to the chart above, it is evident that the linear economy is a unidirectional production method and waste disposal is the result. In contrast, the circular economy or closed production system provides a solution to waste disposal. In this method, the commodity at the end of the first cycle of consumption becomes a resource of the next cycle of the commodity. In this way, waste enters the manufacturing process continuously generating more value (for example, see European Commission, 2014). This is the primary distinction between linear and circular economy methods. Figure 2 illustrates the circular economy production model.

Figure 2- Circular economic model



Source: Stahel, 2013

In certain commodity production, waste can be reused without undergoing any manufacturing process. For example, apparel can be resold after being sorted and graded into high-grade condition clothing obtained from the apparel industry's collection process through take back programmes, charity shops, textile banks, and other means (Koszewska, 2018). The waste created will enter the production process again at consumption without adding any value. For certain other products, where waste created can be recycled, it will enter the production process at the product manufacturing stage, adding more value to the waste product. This is known as reverse logistics in manufacturing. For example, H and M cooperated with I:CO, a specialist of clothing and shoe reuse and recycling solutions, enabling reverse logistics and recycling of their garments. I:CO's German operation collects 25 to 30 trucks full of H and M collection bins every day to be recycled and reused (Eder-Hansen, et al., 2017). Therefore, a significant advantage of the circular economic model is its capacity to reuse products, components, and resources by way of reprocessing, repairing, renovating, cascading and upgrading the waste generated by consumption. (Ellen MacArthur Foundation, 2013, Rashid, *et al*., 2013; Mihelcic, e*t al.*, 2003; Braungart, *et al.*, 2007).

The circular economy method promotes less use of virgin resources or reduces overconsumption of resources and harmful energy largely by adapting to renewable technology in the manufacturing process. (Andersen, 1997, 1999, 2007). The circular economy method also has the capacity to employ performance-based business methods, such as shared economies. For example, Grover, an electronics manufacturer in Berlin, earned €37 Mn through introducing shared economy where they allow greater access for their technological products on rental basis. Grover uses the "pay as you go" model for their technological products, where this strategy fits into the broader post-ownership tendency, in which customers are increasingly spending subscription fees to rent commodities instead of buying them permanently by reducing resource wastage and use of virgin resources (Ingham, 2018). Therefore, this offers business a competitive advantage over the rival firms of the linear economic method. In addition, the circular economy method demands specialists from various technical fields generating more employment opportunities. These specialists labour to design and build functional and sustainable circular economic manufacturing processes (Ellen MacArthur Foundation, 2013) such as incorporating digital technology, designing for the future, conserving and extending product life and rethinking business models (EHERO, 2016).

Eurostat data for 2011 indicate that out of 65 billion tons of input resources, 2.7 billion tons end up as waste. At least 40 percent of the waste is in the reusable state (Ellen MacArthur Foundation, 2013). These figures indicate the substantial amount of wastage is associated with the linear economic model. Waste increases the cost of

production and the price of finished goods and services. The higher price will limit market access to certain segments of the community, resulting in a decline in demand and market expansion.

The increase in food and nonfood commodity prices was rapid in the first decade of the 21st century than in any other time in the 20th century. The main factors attributed to the increase in prices were identified as the increase in population, urbanization, and the increase in the cost of resource extraction. With the development of global ecological concerns, extraction of new resources has become very costly (Ellen MacArthur Foundation, 2013). Soon, the demand for natural resources such as oil, coal, iron ore, and other primary resources is estimated to increase by one third and emerging market economies are estimated to contribute 90 percent of increase in demand for natural resources (Dobbs, et al., 2011). It is evident that with an estimated increase of the global population to 10 billion, the linear economic model will not be sustainable (Ellen MacArthur Foundation, 2013). In the future, the most profitable manufacturing method would be that with more savings in waste management and low harmful impact on ecology, such as the circular economic model.

3. Overview of Sri Lankan industry practises

The Sri Lankan economy consists of the agriculture, manufacturing and services sectors. Currently, the agricultural sector contribution to GDP stands at 7 percent. The main products in the agricultural sector are Oleaginous fruit, tea, spices, and animal food. Currently, the industrial sector contributes 26.4% to GDP of which 15.6 % are from the manufacturing industry. The service sector, the largest of the three sectors, contributes 57.4 percent to GDP. Wholesale and retail trade, transportation, storage and processing service activities are the largest contributors to GDP in the service sector (CBSL, 2020). In Sri Lanka, the growth of the agricultural sector is very slow and volatile. Unfavourable weather conditions, lack of modern agricultural technology, increase competition for certain export-orientated agricultural products, bottlenecks in domestic distribution and storage, and unfavourable prices for agricultural goods suppliers are considered as the main factors behind slow growth, especially in sectors such as fishing, forestry, and growing of major crops, i.e., rubber and tea. As a result, compared to the 6.5% increase in 2018, the Sri Lankan agriculture industry only grew or adds value marginally by 0.6% in 2019 (CBSL, 2020). The growth too is not very encouraging. The main contributing sub-sectors of the manufacturing sector are textiles and garments, construction, mining, and quarrying

activities in the last decade (CBSL, 2020). [3]The services sector is the only sector that shows steady growth[4].

Although there is no documented information, most of the business enterprises in Sri Lanka employ the linear economy method. That means that the country is at a waste receiver stage due to lack of an inbuilt recycling mechanism in the Sri Lankan industry. To illustrate this condition, the study is focussing on a few consumer goods in the fast-moving consumer goods (FMCG) category as proxies. They are mobile phones in the electronic products category, garments in the apparel industry category, and mining in the mining and quarrying industry category.

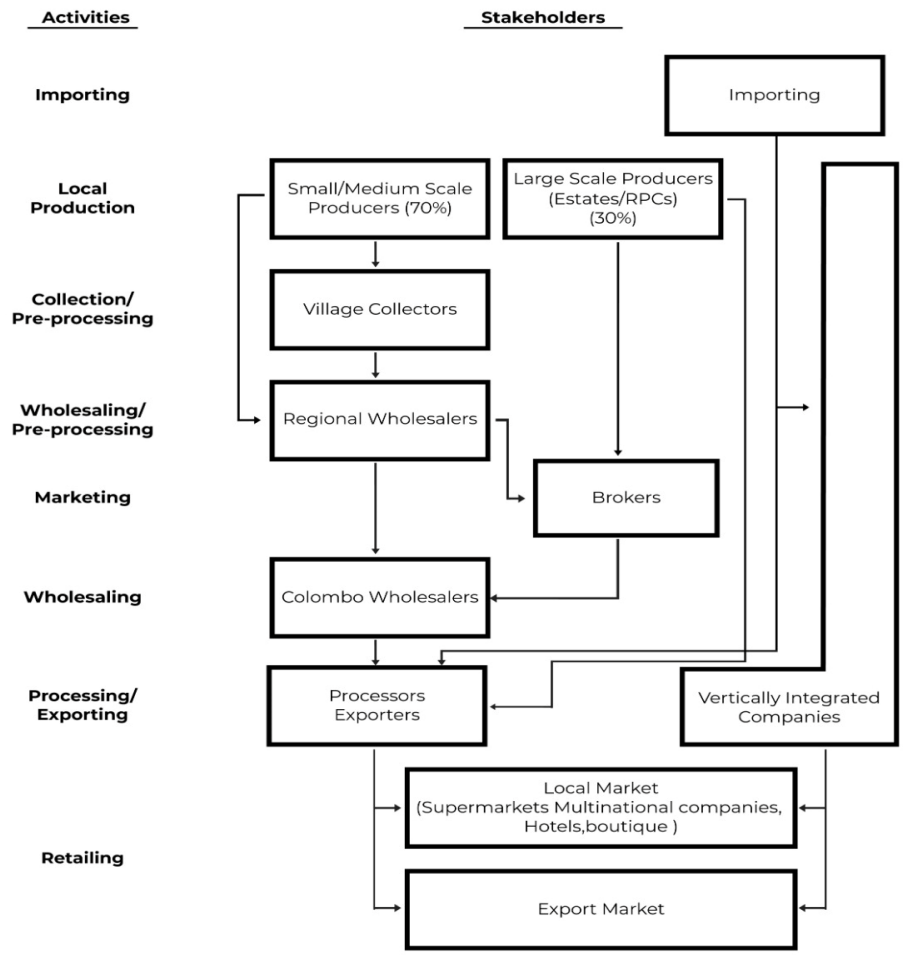
The FMCG industry incurs food waste during production and processing while consumers and retailers' behaviour of handling FMCG products to generate higher wastage (Parfitt, Barthel and Macnaughton, 2010). In the FMCG industry, food losses and waste occur throughout the entire production process due to factors such as destruction during transportation or insufficient transportation infrastructure, complications in storage, damage during processing or contamination, and improper wrapping (Girotto, *et al*., 2015). According to Bandara (2008) Sri Lankan Municipal Solid Waste (MSW) comprises 65-66 percent of perishable organic material and it is assumed that more than 50 percent of MSW is food waste (Sri Lanka Institute of Local Government (SLILG), 2008). According to a survey conducted in the Eravur Pradeshiya Sabha area of Batticaloa district, each residence produces an average of 2.06 kg of food waste daily, accounting for 79 percent of the total garbage produced in the territory (Thirumarpan, *et al.*, 2015).

Below to Figure 3, the Sri Lankan FMCG value chain ends when products reach retailers or the export market and is not connected back to the customer to collect FMCG product waste from users such as packaging and food.

[3] According to Perera (2013), due to business partnership with leading global brands such as Victoria's Secret, Gap, Nike, Tommy Hilfiger, Ralph Lauren and Marks and Spencer manufacturing sector is contributing positively to value addition and GDP.

[4] Due to national security related issues the service sector growth has declined to 2.3 percent which is the lowest growth registered in five years (CBSL, 2020).

Figure 3 - The consumer goods FMCG value chai



Source: Institute of Policy Studies

In the electronic industry, mobile phones are very significant in Sri Lanka. According to Kemp (2020), there are about 31.8 million mobile connections in operation for a population of 21.8 million, indicating more mobile connections than the number of people living in Sri Lanka. Currently, the demand for mobile phone growth is about 15 percent a year (Thavalingam & Karunasena, 2016). Due to 10.1 million Internet users and a 47 percent internet penetration rate, Sri Lanka's smart phone market is currently increasing at a rapid rate of 11 percent annually. Furthermore, the "Made in Sri Lanka" and "Digital Sri Lanka" movements are expected to increase smart phone usage in Sri Lanka by 48% in the immediate future (Business News, 2020). This is higher than the average growth rate of any other electronic appliance (Thavalingam & Karunasena, 2016). The statistics indicate a high probability of the generation of waste based on mobile phones.

The type of plastic, one of the main materials used in phone manufacturing, is of lower grade and therefore economically unviable to make it recycle. The other parts of mobile phones are made of expensive heavy metals such as copper, cobalt, silver, cadmium, mercury, gold, and palladium. The waste of these metals does have negative consequences on the ecosystem[5](Musson, *et al.*, 2006; Ylä-Mella, *et al*, 2007). In addition, harmful substances such as paint and lead-based coatings are found in electronic circuits of mobile phones. Currently, mobile phone manufacturing process does not offer any solution to the waste explained above (Ylä-Mella, *et al.*, 2007). It is evident that the application of the linear economic model in the electronic industry is creating more adverse effects on society.

In the clothing industry, export-orientated apparel manufacturing is a key industry in Sri Lanka. The apparel industry contributes significantly to Sri Lanka's GDP in terms of employment, foreign exchange earnings, and income generation. Textile and wear apparel production in Sri Lanka is one of the largest sub activities in the manufacturing sector and thus contributes to almost entire value addition derived by the Sri Lankan manufacturing sector (CBSL, 2020). On average, the apparel industry has grown by 6.22% (textile) and 5.98% (wearing apparel) in the last five years.

In the 1980s, the appeal industry changed from the existing conventional model to the so-called fast-fashion business method[6]. In the early 1990s, price competing "fast-

[5]An average size mobile phone comprises about 35-40 percent toxic metallic elements (Wu, et al., 2008). Metals such as Zinc, Arsenic, Cadmium, Nickel, Copper, Lead and Beryllium in the mobile phone are persistent and bio accumulative toxins (PBTs) which is supposed to induce cancer and reproductive, neurological and developmental issues in humans (Most, 2003).

[6]Under the fast fashion business method, fashion trends change frequently.

fashion discounters" dominated the industry[7]. As a result, the conventional fashion industry that was there before the 1980s faded away from the market (Wyman, 2015). Due to competitive pricing and clothing with the latest fashion, consumers were over consuming apparel products. Finally, the economy was glutted with affordable apparel products that would be disposed within a short time span (Remy, et al., 2016).

The existing value chain of the global apparel industry including Sri Lanka highly depends on fibres such as polyester, cotton polyamide, polypropylene, etc., which are associated with adverse environmental consequences when they are disposed (Khan & Malik, 2013)[8]. Therefore, the use of a linear economy in the apparel sector is becoming more and more unsustainable.

The discussion so far has highlighted the application of the linear manufacturing method in Sri Lanka and the associated challenges in the FMCG, electronic, and apparel industries. In the next section, the study focusses on the implementation of the circular method.

4. Barriers to implementing circular economy model in Sri Lanka

In the relevant literature, eight types of barriers to implement the circular economy model is documented. They are highlighted as customer-related barriers, value chain related barriers, market barriers, business model-related barriers, financial barriers, coercive barriers, limitations arising from organisational strategies and capabilities, and barriers arising from technical limitations (Mont, et al., 2017). However, as Kirchherr, et al. (2019), study highlights, the cultural barrier, is the most influential barrier and the eight barriers given above are, in fact residuals of the cultural barrier. According to the concept of cultural barriers, the lack of consumer interest and awareness of the benefits associated with the circular economy is the main contributing factor that makes companies to continue with the linear economic model.

There are two market barriers in the apparel industry to adapt to the circular economy method. Firstly, recycled clothing is not appealing to the Sri Lankan customer and therefore there is no potential market. Secondly, due to low-cost virgin material availability for the apparel industry, the expensive clothing recycled process is unviable (Koszewska, 2018). Due to the unavailability of technological know-how and expertise, certain circular economy production methods such as collecting and sorting garments by fibre content, extracting fibre from blended mixtures and composite structures of clothing are currently not possible in Sri Lanka. (Koszewska,

[7]Under this method, fashion trends change even faster through competitive pricing.

[8]Polyester is made from petroleum based synthetic fibre while cotton consumes large volumes of water and pesticides to grow. Textile dyeing causes more damage when untreated dye wastewater is frequently released into local waterways, releasing heavy metals and other toxic substances which are harmful for community health (Khan & Malik, 2013).

2018). It is evident that the adoption of the circular economy method to the clothing industry in Sri Lanka is barred by market, financial and technological barriers.

Lack of governmental support by way of tax and financial incentives, material import privileges to enhance clothing quality for long-term usage are other challenges faced by the clothing industry to transform itself into a circular economy method. In the literature, this type of bottlenecks are considered as coercive barriers to the circular economy (Koszewska, 2018; Rodrguez, 2017). Limited availability of information on the benefits of the circular economy model, such as better revenue and sustainable long-term growth of business, make firms in the apparel industry difficult to develop comprehensive strategies to harness the benefits of the circular economic model (Ellen MacArthur Foundation, 2013).

For the apparel industry, which is notorious for its fast-fashion consumption and waste, the government can introduce sustainability certifications for brands practicing circular economy principles. Such certifications can incentivize brands to adopt sustainable sourcing, production, and recycling processes. Additionally, tax breaks or subsidies could be offered to companies investing in eco-friendly fabric innovations or recycling technologies. To further reduce textile waste, the government could initiate nationwide campaigns promoting clothing repair and upcycling, partnering with local artisans and tailors. Furthermore, establishing mandatory take-back schemes for brands, where consumers can return old clothing items for recycling, could foster a culture of circularity in fashion consumption (Pal and Gander, 2018).

In the electronic industry in Sri Lanka, the forward and reverse supply chain is important aspects when shifting to the circular economic method(Wahjudi, Gan, Anggono, & Tanoto, 2018). In the reverse supply chain, the disposed items re-enter to the production cycle. The process through which the product is remanufactured in this way and taken to the consumer is called the forward supply chain. Thus, the forward supply chain involves repackaging, restocking, resale and finally the disposal (Lund, 2004).To adapt the circular economy to the electronic industry, these two supply chains should work simultaneously, which is not feasible in the current electronic industry in Sri Lanka (Wahjudi, et al., 2018) .

According to Ranasinghe and Athapattu (2020), in Sri Lanka public awareness of the adverse effects of e-waste and the management of e-waste is at very low levels This has resulted in unsystematic disposal of e-waste and thus the reverse supply chain is difficult and uneconomical. This is a cultural barrier that restricts the adoptiom of the circular economy method in the electronic industry.

The lack of proper legal infrastructure and the absence of a legislature-led electronic waste management system hinders the adoption of a circular economy model in the electronic industry. This is a coercive barrier. Currently, only mobile phone devices,

computers and accessories have a systematic waste disposal system. However, other types of electrical and electronic waste such as washing machines, photocopiers and televisions are not included in the existing e-waste disposal system in Sri Lanka. Current practice has a negative impact on the reverse supply chain.

Formal sector (state-recognised) businesses are reluctant to engage in the recycling and remanufacturing process due to the extensive legal procedures that must be followed. Companies have to go through complicated channels to obtain permits and approval. The absence of government directives on waste management practices and the delay in developing simple and proper legal procedures that encourage efficient e-waste disposal in Sri Lanka act as a barrier to the adoption of circular economy in the electronic industry. Government involvement is an essential element to streamline electronic and electrical waste management in Sri Lanka (Wahjudi, et al., 2018).

Ranasinghe and Athapattu (2020) highlight the technical deficiency in implementing forward and reverse supply chains as a significant barrier to adopt the circular economy method in the electronic industry. It is acknowledged that substantial technical barriers are evident in repairing, remanufacturing, and recycling mobile phones and other electronic devices. Repairing is a part of reverse logistics in closed-loop supply chain and requires highly skilled technicians and sophisticated equipment to make reverse logistics successful. Resource limitation and the smaller size of the market in Sri Lanka make it difficult to fulfil them (Wahjudi, et al., 2018).

The e-waste challenge of the electronics industry calls for stringent regulations and innovative policies. Governments can promote Extended Producer Responsibility (EPR) regulations, wherein electronic manufacturers are made responsible for the entire lifecycle of their products, including recycling and disposal. This not only encourages manufacturers to design products that are more durable and repairable but also to set up infrastructure for proper e-waste management. Subsidies or tax incentives can be provided to companies investing in modular designs, which allow easier component replacement and upgrade. Collaborative initiatives between government and industry can also foster Research and Development in green electronics, leading to products that have a lesser environmental footprint right from their inception (Ongondo, et al, 2011).

The FMCG industry generates three types of waste associated with product packaging, food products and food raw material (industrial waste), and product disposal (household waste) (Aarnio and Hämäläinen, 2008). According to Munasinghe (2015), 42 percent of consumables of households, restaurants, supermarkets, and meat shops become waste. This shows the level of waste and the subsequent harmful impact on the environment of the linear economic method.

As mentioned elsewhere in this study, lack of understanding of the pros and cons of FMCG industry-based waste tends consumers to make suboptimal decisions that would have harmful environmental implications. Often the information given on the label and packaging can be misleading and, in such cases, consumers take consumption decisions based on faulty information. For instance, information given on labelling and packaging indicates that bioplastics are environmentally friendly, but the reality is much more complicated[9]. This is a customer-side barrier that hinders the application of reverse logistics (World Wide Fund For Nature, 2016).

However, reverse logistics in the FMCG sector comes at a cost. Reverse logistics involves inspecting, licencing, and monitoring to bring the disposed product back to the manufacturing process. All these stages increase the cost to the manufacturer[10]. Compared to waste, the product ends up being much cheaper to the manufacturer. The cost factor explained here is a financial barrier that makes manufacturers reluctant to adopt a circular economy method.

The presence of coercive barriers in the FMCG industry also hinders the circularity within the industry. The development of waste classification guidelines helps to improve customer awareness and participation in waste sorting which is a necessity for the circularity. An investigation of local trash regulations of 37 municipalities in Sri Lanka revealed that there is no uniformity in the nomenclature and colour coding of waste classification. This can be considered a coercive restriction associated with the Sri Lankan FMCG industry. For example, lack of clarity in classifications such as "biodegradable, mixed, and combustible garbage". In addition, the classification of dry waste refers to a variety of different types of waste depending on the municipality. Colour coding such as grey, brown, and blue corresponds to approximately ten different types of waste. The lack of uniformity in municipal waste restrictions hinders the development of country-wide standardisation of waste classification guidelines for sales packaging for closed-loop supply chain (Aarnio and Hämäläinen, 2008).

The traceability of the value chain is another crucial factor for the circular economy method to be successful. Techniques to increase visibility of the supply chain help to recognise every action of vendors and consumers along the value chain. FMCG companies in Sri Lanka must incorporate traceability techniques into the production

[9]Bio plastics are made of agro feedstock but in the process harmful chemicals are added. Therefore, the final environmental impact most possibly be equal to fossil-based plastic (World Wide Fund For Nature, 2016).

[10] Regulating and monitoring the manufacturing process to suit the circular method and segregation and segmentation of the waste into different distribution networks are more expensive than the linear manufacturing method (World Wide Fund For Nature, 2016).

strategy to reduce environmental and social risks (World Wide Fund For Nature, 2016).

The evidence suggests that the current products of the FMCG industry are not at all in line with circular economic model. To make them fall into the circular economy model, a substantial amount of technical advancement is necessary. On the other hand, challenges to maintain hygiene and safety of products is another area of concern. For example, the right technology for recycling or re-purposing FMCG product packaging is very important. These are a few technical barriers for the FMCG sector to transform into a circular economy model.

The FMCG sector, characterized by its rapid consumption and turnover of products, can benefit from policies that incentivize sustainable packaging. Governments can introduce regulations mandating a certain percentage of packaging to be either recyclable or compostable. Tax breaks or financial incentives can be offered to companies exploring alternative, sustainable packaging solutions or investing in refill stations. Public-private partnerships can also be beneficial, establishing infrastructure for consumers to return packaging or containers for reuse or recycling. Additionally, creating awareness campaigns about the importance of sustainable consumption, in tandem with industry stakeholders, can shift consumer behavior towards products that align with circular economy principles (Korhonen, et al., 2018).

5. Factors influencing the implementation of the circular economy in Sri Lanka

The Sri Lankan apparel industry is based on a 'resource intensive supply chain' that uses a substantial amount of available resources in the manufacturing process. As a result, the apparel manufacturing process pollutes water, soil, and air. The apparel industry is among the top ecological disrupting industries in the world (Leonas, 2016). The apparel industry in Sri Lanka is no different from this global phenomenon and contributes waste up to 0.5-1 percent of the total municipal sewage disposal (the amount of pollution is equal to 7344 tons annually). The Sri Lankan apparel industry consumes 19,000 to 38,000 tons of fabric per year and generates 10 to 20 percent of clothing cutting waste (Jayasinghe, *et al*., 2010). It is estimated that only 25 percent of waste is reused and recycled. The balance 8,000 to 19,000 tons of fabric waste per year are burnt, contributing to air pollution (Jayasinghe, *et al*., 2010).

The Sri Lankan textile and apparel industry is highly dependent on imported raw materials. About 70 to 90 percent of the key resources are imported. This is a major bottleneck for the Sri Lankan apparel industry to be competitive in the world market (Dheerasinghe, 2009).

The negative environmental impact and the increase in the cost of raw material due to high reliance on imports under the current linear economic model is evident beyond

any doubt. The most appropriate answer to this issue is the adaptation of the circular economic method in apparel. The circular economy has the ability to bridge the gap between natural resource depletion and resource consumption growth in the textile industry (Andersen, 2006). The circular economy method will make the Sri Lankan clothing industry environmentally friendly and apparel products are more competitive on the global market.

It is evident that uninterrupted supply of virgin raw material for the electronic industry without price escalation may not be possible in the future. That means that the cost of production of mobile phones is expected to rise at a rapid pace. When the demand for electronic devices such as mobile phones is growing fast, the prices of mobile phones can increase even faster.

Current technological progress assures that about 80% of the mobile phone waste is now recyclable ready[11]. For example, using melting technology, in addition to metal and plastic components, other parts such as LCD screens, lenses, microphones, battery connectors, SIM cards, and phone cases can be recycled as well (Thomas, 2012). This new technology helps to maintain control over the expected escalation in the production cost.

It is evident that in some parts of the world, currently innovative production methods are in practice that encourage the development of the circular economy method in the electronic industry. For example, the PuzzlePhone, a mobile device made in Finland, is a sustainable product with the facility to upgrade its components[12]. As a result, the average lifespan of this mobile device is about 10 years, which is well above the average lifespan of a standard mobile phone device (PuzzlePhone, 2015). This is useful innovation to experiment with in economies such as Sri Lanka to employ the circular economic method in the electronic industry.

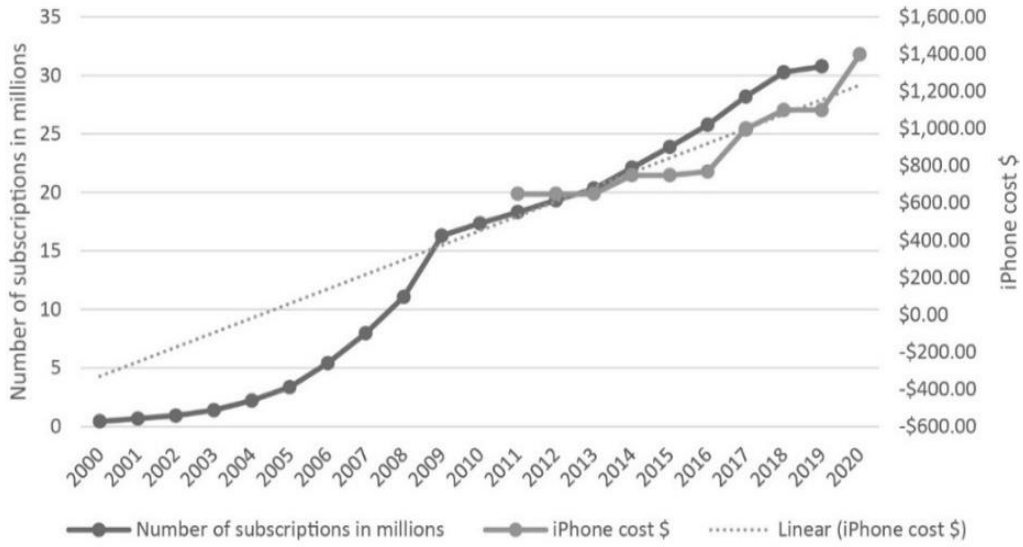
Figure 4 shows the number of mobile phone connections from 2000 to 2019 in Sri Lanka. It very clearly indicates a rapid increase in the demand for mobile phones over time, while mobile subscriptions increased from 0.43 million in 2000 to about 31

[11]In Sri Lanka, e-waste disposal per capita is estimated to be 6.3 kg annually. Bangladesh generates 1.2 kilogram of e-waste per capita, while India generates 2.4 kg. Germany, as an Eu state, produces 19.4 kg of e-waste (The Global E-waste Statistics Partnership, 2017). Personal computers, printers, televisions, mobile phones are the five main E-waste contributors in Sri Lanka (Ranasinghe & Athapattu, 2020) .

[12]Less durability and rapid design changes are the main reasons for consumers to discard mobile phones at regular intervals. PuzzlePhone consist of three modules, namely brain, spine and heart. These modules can easily be upgradable to suit the changing customer preferences. This is a fine example of a balance among aesthetics, functionality and sustainability of the product.

million in 2019 in Sri Lanka (Statistica, 2018). Rapid increase in subscription indicates the resource requirement in the mobile phone industry. Figure 04 shows how the cost of iPhones increases year after year, so from 2011 to 2020, the cost climbed by nearly 115 percent (Supan, 2020). According to Kastrenakes (2019), this is primarily due to the increased cost of production caused by rising resource prices. If the electronic industry continues to use a linear economic model, the growth and profitability of the industry may not be sustainable. Adopting into circular economy method seemed a viable option.

Figure 4- Comparison of costs for smartphones

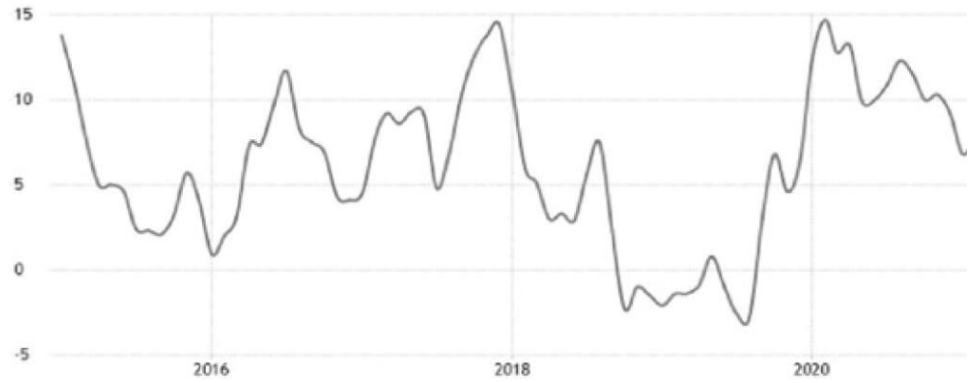


Source: Developed by the author based on Statistica (2018), Supan (2020), and Peng (2019)

The supply chain of the FMCG industry in Sri Lanka is currently based on the linear economic model. Inefficiencies associated with linear economic model result in significant food waste in the industry (Rezaei & Liu, 2017). Figure 5 explains the food inflation in Sri Lanka for the last five years[13].

[13] According to Trading Economics (2021), food inflation rate in Sri Lanka is 9%, consumer price index- CPI is 140.30, core consumer prices is 141.30 and GDP deflator is 151.90 as at April, 2021.

Figure 5: Food inflation in Sri Lanka from 2015 to date



Source: Trading Economics, 2021

According to Carlsson-Kanyama and Gonzales (2009), high and volatile food inflation in Sri Lanka is largely attributed to resource depletion and increased manufacturing cost. This indicates how the inefficiency of the linear economic model contributes to food inflation and ultimately the decline in the purchasing power of consumers.

The zero-in-waste method adopted by Unilever, an FMCG company in Sri Lanka, can be considered an example of a successful circular economic production model[14]. The company used smart acquisition of raw material and reuse or resell of leftover resources[15] to maintain zero waste. In this manner, Unilever was able to save / earn $226 million through its zero-waste production method (Himmelfarb & O'Dea, 2015). This is a great example to understand the benefits of the circular economy method.

6. Drawbacks of a circular economy

While the circular economy model presents a sustainable alternative to the traditional linear economic model, it is not devoid of challenges. One of the primary obstacles is the initial investment required to transition from a linear to a circular model. This transition often necessitates the redesign of products, development of new technological infrastructure, and establishment of new supply chains, all of which can be capital-intensive (Bocken, *et al.* 2014). Especially for developing economies or

[14] Unilever in its corporate newsletter mentions that they can gain zero waste through circular business practices. Currently, Unilever is adapting it in throughout its production chain of 240 factories in 67 countries.

[15]Certain resources are reused on site, while others are sold into other commercial value chain, and produced compost from organic waste.

small to medium enterprises (SMEs), this upfront cost can be a deterrent, despite the potential long-term gains.

Another challenge relates to the complexities in implementing and managing a circular system. For products to be truly circular, they need to be designed for durability, reparability, and recyclability. Achieving this requires cross-sector collaboration, harmonized standards, and an evolved consumer mindset towards product usage and disposal (Geissdoerfer, *et al*., 2018). Moreover, as the circular model emphasizes product longevity, businesses accustomed to profits from frequent consumer repurchases might encounter financial restructuring challenges.

At last, the circular economy, while minimizing waste, does not necessarily eliminate it. Some residual waste will always remain, and the challenge lies in managing and minimizing its environmental impact (Lieder and Rashid, 2016). Furthermore, there is a risk of creating a secondary market for 'recycled' products, which, if not monitored, could inadvertently encourage excess consumption under the guise of sustainability.

7. Conclusion

Most industries in Sri Lanka practices linear or take-make-dispose economic model despite the long-term benefits of circular method. Under the linear economic model, environmental degradation is high, but, since cost on environmental degradation is not part of the production cost (or private cost), business enterprises can accumulate wealth at a faster rate under the linear method.

The circular economy is an alternative production method that originated decades ago in response to the increase in production costs and environmental degradation. The circular method can reduce both private and social costs associated with production. Some business organisations in Sri Lanka are making progress with the circular method using long-term benefits.

Key obstacles to the circular economy in Sri Lankan industries are lack of interest and knowledge and the reluctance of corporate entities due to less technical and financial capabilities coupled with incompatible corporate strategies of the business enterprises. Less complexity and depth of the regulatory framework also act as a barrier for the development of a circular model.

The government role in promoting the circular method in Sri Lanka is paramount to provide guidance and assistance in the areas of well-structured regulatory framework and a well formulated plan to overcome financial and technical barriers of individual industries.

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List of references

Aarnio, T., & Hämäläinen, A. (2008). Challenges in packaging waste management in the fast-food industry. *Resources,Conservation and Recycling*, *52*(4), 612–621. https://doi.org/10.1016/j.resconrec.2007.08.002

Andersen, M. (1997). *Evaluation of the cleaner technology programme, Environmental Review No.14.* Environmental Protection Agency. Retrieved 11 13, 2020, from https://pure.au.dk//portal/files/86521632/cleanertechn_uk.pdf.

Andersen, M. (1999). Governance by green taxes: Implementing clean water policies in Europe 1970–1990. *Environmental Economy Policy Studies*, 39–63. Retrievedfrom https://pure.au.dk/portal/files/12075926/Andersen_Governance_by_green_taxes.pdf

Andersen, M. S. (2006). An introductory note on the environmental economics of the circular economy. *Sustainability Science*, *2*(1), 133–140. https://doi.org/10.1007/s11625-006-0013-6

Andersen, M. (2007). An introductory note on the environmental economics of the circular economy. *Sustainability Science and Springer*, 133–134. Retrieved from file:///C:/Users/Chathurya/Downloads/Andersen.%20%20an%20introductory%20note%20on%20he%20environmental%20economics%20of%20the%20circular%20economy.pdf

Bandara, N. J. G. J. (2008). Municipal Solid Waste Management - The Sri Lankan Case. *Proceedings of International Forestry and Environment Symposium*, . https://doi.org/10.31357/fesympo.v0i0.21

Braungart, M., McDonough, W., & Bollinger, A. (2007). Cradle-to-cradle design:

Creating healthy emissions-a strategy for eco-effective product and system design. *Journal of Cleaner Production*, *15*(13), 1337-1348.

Carlsson-Kanyama, A., & Gonzales, A. (2009). Potential contributions of food consumption patterns to climate change. *Epidemiology*, *20*, S238. https://doi.org/10.1097/01.ede.0000362799.46174.56

Central Bank of Sri Lanka. (2020). *Annual Report 2019 | Central Bank of Sri Lanka.* Colombo.

Desrochers, P. (2002). Regional development and inter-industry recycling linkages: Some historical perspectives. *Entrepreneurship and Regional Development - ENTREP REG, 14*. doi:10.1080/08985620110096627

Desrochers, P. (2004). Industrial symbiosis: The case for market coordination. *Journal of Cleaner Production, 12*(8-10), 1099-1110. doi:10.1016/j.jclepro.2004.02.008

Dheerasinghe, R. (2009). Garment industry in Sri Lanka challenges, prospects and strategies. *Staff Studies*, *33*(1), 33. https://doi.org/10.4038/ss.v33i1.1246

Dobbs, R., Oppenheim, J., Thompson, F., Brinkman, M., and Zornes, M. (2011).*Resource revolution: Meeting the world's energy, materials, food, and water needs.* McKinsey and Company. Retrieved from https://www.mckinsey.com/business-functions/sustainability/our-insights/resource-revolution

Eder-Hansen, J., Chalmer, C., Tärneberg, S., Tochtermann, T., Seara, J., Boger, S., & Jäger, K. (2017). *Pulse the fashion industry*. Global Fashion Agenda and The Boston Consulting Group.

EHERO. (2016). *CIRCULAR JOBS Understanding Employment in the CircularEconomy in the Netherlands*. Retrieved from website: https://circulareconomy.europa.eu/platform/sites/default/files/circular_jobs.pd

Ellen MacArthur Foundation. (2013). *Ellen MacArthur Foundation Towards the Circular Economy Vol.1*. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

Ellen MacArthur Foundation. (2018). *What is the circular economy?* Retrieved fromEllenmacarthurfoundation.org: https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy

Frosch, R.,& Gallopoulos, N. (1989). Strategies for manufacturing. ScientificAmerican. *Scientific Research Publishing*, 261, 144-152.

Geissdoerfer, M., Savaget, P., Bocken, N. M. P., & Hultink, E. J. (2017). The circular economy—A new sustainability paradigm? Journal of Cleaner Production, 143, 757-7 68

Geissdoerfer, M., Vladimirova, D. & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production, 198(1), pp.401–416*. doi:https://doi.org/10.1016/j.jclepro.2018.06.240

Geng, Y., Zhu, Q., Geng, Y., Zhu, Q., Doberstein, B. & Fujita, T. (2009). Implementing China's circular economy concept at the regional level: A review of progress in Dalian, China. *Waste Management, [online] 29(2), p.996*. Available at: https://www.academia.edu/6461981/Implementing_China_s_circular_economy_concept_at_the_regional_level_A_review_of_progress_in_Dalian_China

Girotto, F., Alibardi, L., & Cossu, R. (2015). Food waste generation and industrial uses:A review. *Waste Management*, *45*, 32–41. https://doi.org/10.1016/j.wasman.2015.06.008

Himmelfarb, N., & O'Dea, K. (2015). From Pepsi to Unilever, 5 circular economy strategies for consumer goods | Greenbiz. Retrieved June 22, 2021, from www.greenbiz.com website: https://www.greenbiz.com/article/pepsi-unilever-5-circular-economy-strategies-consumer-goods

Ingham, L. (2018) Electronics join sharing economy as technology subscription service Grover raises €37m. Verdict. https://www.verdict.co.uk/electronics-sharing-economy-technology-subscription-service-grover

Institute of Policy Studies of Sri Lanka. (2017). *Introduction to value chain analysis(VCA): Cencept, methodologies, and its application in Sri Lanka.*Sri Lanka: Institute of Policy Studies of Sri Lanka.

Kastrenakes, J. (2019). How phones went from $200 to $2,000. [online] The Verge. Available at: https://www.theverge.com/2019/3/18/18263584/why-phones-are-so-expensive-price-apple-samsung-google

Kemp, S. (2020). *Digital 2020: Sri Lanka*. Retrieved from Data Reportal – Global Digital Insights: https://datareportal.com/reports/digital-2020-sri-lanka

Ketels, C., & Protsiv, S. (2017). *Priority Sector Report: Circular Economy European Cluster Observatory Report.* Retrieved from https://ec.europa.eu/docsroom/documents/24681/attachments/3/translations/en/renditions/native#:~:text=The%20main%20sub%2Dsectors%20include

Khan, S., & Malik, A. (2013, 10). Environmental and Health Effects of Textile Industry Wastewater. *Environmental Deterioration and Human Health: Natural and Anthropogenic Determinants*, 55-71. doi:10.1007/978-94-007-7890-0_4

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., & Hekkert, M. (2019). Barriers to the circular economy: evidence from the European Union (EU). *Ecological Economics*, 264-272.

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics*, *143*, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

Koszewska, M. (2018). Circular Economy — Challenges for the Textile and Clothing Industry. *Autex Research Journal*, *18*(4), 337–347. https://doi.org/10.1515/aut-2018-0023

Leonas, K. K. (2016). The Use of Recycled Fibers in Fashion and Home Products. *Textile Science and Clothing Technology*, 55–77. https://doi.org/10.1007/978-981-10-2146-6_2

Lund, R. T. (2004). *Design and manufacture for sustainable development* (B. Hon, Ed.). Bury St. Edmunds: Professional Engineering Pub.

McDonough, W., & Braungart, M. (2002). *Cradle to cradle: remaking the way we think.* New York: North Point.

Mihelcic, J.R., Crittenden, J.C., Small, M.J., Shonnard, D.R., Hokanson, D.R., Zhang, Q., Chen, H., Sorby, S.A., James, V.U., Sutherland, J.W. & Schnoor, J.L. (2003),Sustainability Science and Engineering: The Emergence of a New Metadiscipline. *Environmental Science & Technology, 37(23), pp.5314–5324.* doi:https://doi.org/10.1021/es034605h.

Mont, O., Plepys, A., Whalen, K., & Nußholz, J. (2017). Business model innovation for a Circular Economy: Drivers and barriers for the Swedish industry – the voice of REES companies. Retrieved June 9, 2021, from undefined website: https://www.semanticscholar.org/paper/Business-model-innovation-for-a-Circular-Economy%3A-%E2%80%93-Mont-Plepys/c8660093c3e568cb9bb4962eb3b52ac21d27f7ae

Most, E. (2003). Calling all cell phones: Collection, reuse, and recycling programs in the US. *Inform*. Retrieved from https://energy-vision.org/pdf/CallingAllCellPhones.pdf

Munasinghe, M. (2015, June 18). The 19A: A Key Step Forward in Sri Lanka's Path Towards Sustainable Human Development. Retrieved July 16, 2021, from Colombo Telegraph. https://www.colombotelegraph.com/index.php/the-19a-a-key-step-forward-in-sri-lankas-path-towards-sustainable-human-development/

Musson, S. E., Vann, K. N., Jang, Y.-C., Mutha, S., Jordan, A., Pearson, B., & Townsend, T. (2006, 05). RCRA Toxicity Characterization of Discarded Electronic Devices. *Environmental Science and Technology*, *40*, 2721-6. doi:10.1021/es051557

Ongondo, F.O., Williams, I.D. & Cherrett, T.J. (2011). How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management, 31(4), pp.714–730*. doi:https://doi.org/10.1016/j.wasman.2010.10.023.

Pal, A., & Gander, P. (2018). Exploring the potential of circular economy in the construction industry. *Journal of Industrial Ecology, 22(3), 543-555*.

Parfitt, J., Barthel, M., & Macnaughton, S. (2010). Food waste within food supply chains: Quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 3065–3081. https://doi.org/10.1098/rstb.2010.0126

Peng, D. (2019). Cell Phone Cost Timeline: How Much Do Cell Phones Cost? Canada. Retrieved from Ooma.com - Smart solutions for home and business. https://www.ooma.com/home-phone/cell-phone-cost-comparison/

Perera, M. (2013). Textile and Apparel Industry of Sri Lanka – an Overview Contents. *www.academia.edu*, 3. Retrieved from https://www.academia.edu/4634295/Textile_and_Apparel_Industry_of_Sri_Lanka_an_Overview_Contents

PuzzlePhone (2015). home. [online] Puzzlephone.com. Available at: http://www.puzzlephone.com/ [Accessed 16 Jul. 2021].

Ranasinghe, W., & Athapattu, B. (2020). *Challenges in E-waste management in Sri Lanka.*

Rashid, A., Asif, F. M., Krajnik, P., & Nicolescu, C. M. (2013). Resource conservative manufacturing: An essential change in business and technology paradigm for sustainable manufacturing. *Journal of Cleaner Production*, 166-177.

Remake (2017). Remake fashion accountability report — remake. [online] Remake. Available at: https://remake.world/2022-remake-fashion-accountability-report/ [Accessed 20 Jul. 2021].

Remy, N., Speelman, E., & Swartz, S. (2016, October 20). Style that's sustainable: A new fast-fashion formula. Retrieved from McKinsey and Company. https://www.mckinsey.com/business-functions/sustainability/our-insights/style-thats-sustainable-a-new-fast-fashion-formula.

Rezaei, Maryam & Liu, Bin. (2017). Food loss and waste in the food supply chain. Nutfruit. 71. 26-27.

Stahel, W. R. (2013). Policy for material efficiency—sustainable taxation as a departure from the throwaway society. *Philosophical transactions of the Royal Society:amathematical, physical and engineering sciences*, *371*(1986), 20110567. https://doi.org/10.1098/rsta.2011.0567

Sri Lanka Institute of Local Government (SLILG). (2008). *Solid waste reduction, service delivery training module 2 of 4*. Sri Lanka: Ministry of Local Government and Provincial Council.

Statistica. (2018). Sri Lanka mobile cellular subscriptions 2000-2018, Statista. Retrieved from Statista https://www.statista.com/statistics/501125/number-of-mobile-cellular-subscriptions-in-sri-lanka/

Supan, J. (2020, October 24). iPhone Price Increases | From $650 to $1,000 in Five years. Retrieved from All connect. https://www.allconnect.com/blog/iphone-price-increases-over-past-decade

Thavalingam, V., & Karunasena, G. (2016, 05). Mobile phone waste management in developing countries: A case of Sri Lanka. *Resources, Conservation and Recycling*, *109*, 34-43. doi:10.1016/j.resconrec.2016.01.017

The Global E-waste Statistics Partnership. (2017). Global E-waste Statistics Partnership. Retrieved from E-Waste website: https://globalewaste.org/

Thirumarpan, K., Thiruchelvam, T., Dilsath, A., & Minhajkhan, M. (2015). *Household knowledge, attitudes and practices in solid waste segregation and management: a study in Eravur urban council area, Batticaloa district.*, Retrieved from http://www.seu.ac.lk/researchandpublications/symposium/5th/abstract/pureandappliedsciences/39.pdf

Thomas, G. P. (2012, August 30). Recycling of mobile phones. Retrieved from AZoCleantech.com, https://www.azocleantech.com/article.aspx?ArticleID=27

Trading Economics. (2021). Sri Lanka Food Inflation | 2009-2021 Data | 2022-2023 Forecast | Historical | Chart. Retrieved June 15, 2021, from tradingeconomics.com. https://tradingeconomics.com/sri-lanka/food-inflation

Upadhayay, S., & Alqassimi, O. (2019). Transition from linear to circular economy.,62-74.

Wahjudi, D., Gan, S. S., Anggono, J., & Tanoto, Y. (2018). Factors affecting purchase intention of remanufactured short life-cycle products. *International Journal of Business and Society, 19*.

World Wide Fund For Nature. (2016). *Asian fast moving consumer goods: A sustainability guide for financiers and companies.* Jennifer Campbell and Mitchell Davies.

Wu, B., Chan, Y., Middendorf, A., Gu, X., & Zhong, H. W. (2008). Assessment of toxicity potential of metallic elements in discarded electronics: A case study of mobile phones in China. *Journal of environmental sciences (China), 20*(11), 1403-1408. doi:10.1016/S1001-0742(08)62240-8

Wyman, O. (n.d.). Oliver Wyman - Impact-Driven Strategy Advisors. Oliver Wyman Impact-Driven Strategy Advisors. https://www.oliverwyman.com/index.html

Xue, B., Chen, X., Geng, Y., Guo, X., Lu, C., Zhang, Z. & Lu, C. (2010). Survey of officials' awareness on circular economy development in China: Based on municipal and county level. Resources, Conservation and Recycling, [online] 54(12), pp.1296–1302. doi:https://doi.org/10.1016/j.resconrec.2010.05.010.

Ylä-Mella, J., Pongrácz, E., Tanskanen, P., & Keiski, R. (2007). Environmental impact of mobile phones: Material content. *In Proceedings of the 22nd International Conference on Solid Waste Technology and Management (pp. 1-9)*. Philadelphia, PA: Drexel University.