

# **Tools and Strategies to Implement Circular Economy in the Face of Changing Times**

## **Introduction**

It is no surprise that humans have continuously and steadfastly depleted the available environmental resources since the advent of the Industrial Revolution. The extent to which this damage has occurred has been estimated by different organizations using different measurable criteria. According to the World Wildlife Report (2012), human activities have increased considerably in the past few decades, so much so that 1.5 times the capacity of Earth will be required to support the existence of mankind. Several environmental thresholds have been defined by Rockstrom et al (2009), which should not be crossed if the ecosystem is to be sustained for many centuries to come. Their most recent study has reported that 4 out of 9 environmental thresholds have already been crossed, including climate change, loss of integrity of the biosphere, alterations in the land system, and corruption of the biogeochemical cycles (Rockstrom et al., 2009). The Millennium Ecosystem Assessment has identified that 15 out of 24 ecosystem services are being irreversibly depleted due to current human activities (Sariatli, 2017). All these, and many other environmental assessment reports, clearly point towards the fact that Earth is rapidly running out of its naturally abundant resources, and if drastic changes are not made, we might face a future that is environmentally disastrous.

This paper talks about a few aspects of the linear economy that countries around the world currently adopt, and how these activities have led to deleterious consequences for the environment. It also proposes a new type of economy – circular economy – that can help protect the natural resources remaining on the planet. The paper details out the different tools and strategies that are required to implement activities of circular economy in different countries around the world. Finally, the paper presents several examples of industries and countries that have already adopted circular economy to different degrees, the challenges they faced, and the results they obtained.

## **Linear Economy – Model and its Impacts on the Environment**

The Ellen MacArthur Foundation (2013) has proposed a resource-based model with roots that can be traced back historically to explain the initiation of the linear economy system in the world. Financial and material resources have been unevenly distributed in different regions of the world, with these resources being concentrated in the developed nations. As a result, resources in these areas have been cheaper compared to the developing nations, making the producers and consumers in these nations more likely to use these resources carelessly. Due to the easy availability of resources, industrialists in these nations have not paid attention to efficient recycling and waste management activities. This has given rise to the foundational principles of the linear economy model which involves using resources, manufacturing goods, selling these goods and making profits, and disposing everything that is not needed at the end.

When production processes in these countries were initiated, the use of resources was in balance; however, as profits improved, industrialists started consuming more resources, producing

more products, and disposing more waste products because it was not humanly possible to recycle large amounts of generated waste. This hyper-production crisis led to a vicious circle where the material resources that were used were not being efficiently replaced in the environment leading to depletion of these resources (Drljaca, 2015). According to a report by the Sustainable Europe Research Institute (SERI), the costs of the linear economy model amounts to 21 billion tons in the form of material resources that are lost during the transition stages of the production pipeline (Sariatli, 2017). In Europe, a 2010 report by Eurostat indicated that out of 65 billion tons of material resources that were used for manufacturing, only 40% of the resources were recycled and 2.7 billion tons were lost as sources of recyclable products and energy (Eurostat, 2011).

The strategies for waste management around the world do not follow a consensus and most nations do not hold large-scale industries accountable for their waste management systems. This heavy negligence on the part of environment safety organizations, both government and non-government, has led to heavy and irreversible damage to the Earth's natural resources. The wealth of our planet is limited, and the current population explosion and the raging technology revolution has increased the need for products beyond capacity. If a drastic step into moving towards a more sustainable economical model is not taken right now, the future of our planet may well be dry, bleak, and devoid of plentiful natural resources (Drljaca, 2015).

### **Moving Towards a Circular Economy Framework**

Recently, environmentalists, world business leaders, and policy makers have begun to strongly advocate a transition towards a more sustainable circular economy model in order to address some of our environmental and economic challenges. The Ellen MacArthur Foundation has played a pioneering role in promoting the benefits of moving towards a circular economy framework, which they have highlighted to be restorative and regenerative by intention and design (Nordic Council of Ministers, 2015).

Although the concept of circular economy has been around since the 1970s, it has only recently started gaining momentum in the context of developing a sustainable future for our planet. During the World Economic Forum (2012), the Ellen MacArthur Foundation along with the McKinsey Company presented a report which estimated cost benefits of up to 630 billion US dollars upon the adoption of a circular economy framework. The financial benefits are yet marginal compared to the massive environmental benefits that will become apparent if every nation in the world adopts this model. In order to make use of the economic benefits and to become a part of contributing to the environment, several large-scale and small-scale industries have started implementing concepts of circular economy in their companies (Wautelet, 2018).

Circular economy is not a single concept; rather, it encompasses several environment-friendly actions such as restoration, use of renewable energy, avoiding use of toxic chemicals, and designing production systems and pipelines such that waste is eliminated to the largest extent possible. One of the primary objectives of a circular economy framework is to eliminate the concept of waste. This is done by disassembling and reusing any resource left at the end of a production cycle. This is different from

concepts of disposal and recycling which may lead to loss of large amounts of resources and energy. Another important objective of circular economy is to classify product components as consumables or durables depending on whether they can be safely returned to the biosphere or not. Durables, comprising of technical components of computers and engines, are not safe for the biosphere and hence, their reuse plan needs to be designed from the beginning of the production cycle. The third objective of a circular economy model is to use renewable sources of energy for production in order to reduce dependence on limited resources and enhance system resilience (Ellen MacArthur Foundation, 2013).

## **Tools and Strategies needed to implement Circular Economy**

Implementing circular economy in a country in a way that reverses the harmful effects of years of destructive environmental practices requires a thorough understanding of the situational challenges of the country and a comprehensive description of actions that can be taken to adopt a circular economy framework. Some of the hallmark features of a circular economy model include lean manufacturing practices, eco-design, industrial ecology, industrial symbiosis, life cycle thinking, sustainable consumption, dematerialization, and product-service systems. Shifting from a linear economy model to a circular economy framework is challenging and time-consuming for industrialists, and so, several organizations around the world have tried to break down the steps required for this transition to make it smoother and easier for companies (Milios, 2018).

Some of the important tools and strategies that can be employed by companies globally to implement circular economy in their production cycles have been discussed below:

### **1. Reuse, Repair, and Remanufacturing**

Circular economy is built on the foundational principles of reuse, repair, and remanufacturing in order to retain the inherent value of products and encourage material circulation in short loops. Products can be made more durable by improving their design so that they can last longer, be repaired easily, don't require constant replacement of components, and have a higher operational utility. Durability of the product is also defined by ease of access to spare parts and repair information so that the product can benefit the user for as long as possible (Maitre-Ekern and Dalhammar, 2016).

It is often seen that manufacturers restrict access to spare parts and prevent other manufacturers from refurbishing and selling old and used products at a reasonable cost. Sometimes, they also restrict repair information for products so that independent repairers cannot help consumers with any product issues they might face. By constantly releasing new versions of products, they restrict reparability by making old parts incompatible with new releases. All these activities on the part of manufacturers stand in the way of implementing a circular economy framework where all products can be reused and repaired (Whalen et al., 2017).

In order to address these challenges, clear guidelines and mandates need to be circulated regarding product reparability, product recyclability, and product lifetime. To provide clear standards for these activities, tools such as the Ecodesign Directive 2009/125/EC can be used to determine energy

efficiency and material resource efficiency of products (Wilts et al., 2016). Other approaches include clearly defining durability information for energy labeling of products, using public procurement criteria for establishing durability requirements, and forming mutual agreements with industries regarding product durability requirements (Dalhammar, 2016).

Some of the key strategies under this category that can help countries develop clear objectives of moving from a linear economy towards a circular economy are given below:

- Recycling

This is one of the oldest and most traditional methods for sustainable production by using byproducts from one production pipeline as raw material for another production process. By recycling old products, the inherent value of existing products is utilized, the use of primary raw materials is reduced, and, on an environmental level, greenhouse gas emissions are reduced which is directly linked to global climate change (EEA, 2016).

- Efficient Use of Available Resources

This process is directly linked to reduced use of primary resources through the careful and efficient use of resources and cleaner production practices. Overall, it can lead to conservation of resources, conservation of sources such as energy and water, and reduction of waste product generation and toxic emissions from production processes. This can be made possible by effective eco-design focused towards extension of product life, recycling, and dematerialization (Habert et al., 2010).

- Use of Renewable Energy Sources

Replacement of non-renewable energy sources with renewable energy sources is a very important step in shifting towards a circular economy framework. As per a report by the European Commission, natural gas, oil, and coal are the most widely used sources of energy that inevitably leads to greenhouse gas emissions, pollution, and climate change. Some of the viable renewable energy sources include biomass, solar power, wind power, and hydro power can be adopted for mainstream uses in order to lessen the harmful environmental impacts due to use of fossil fuels as energy sources (European Commission, 2016).

## **2. Industrial Ecology and Industrial Symbiosis**

Industrial ecology involves designing industrial systems on the basis of natural ecosystems such that energy and resource loops can be closed and impacts on the environment can be minimized. This concept has been used to design several eco-industrial clusters where collaboration between partners in efficient management of resources leads to enhanced economic performance and positive environmental impacts (Ehrenfeld, 2004). This co-operative network within the clusters where individual business entities exchange materials, services, and infrastructure in order to enhance their competitive advantage in the market is also referred to as Industrial symbiosis. Industrial symbiosis is defined as an interactive approach in which different industries exchange resources such as materials, energy, water, and by-products in order to move towards sustainable development practices. This approach can

effectively address issues of waste management and resource depletion through mutually beneficial relationships amongst industrialists (Chertow, 2007).

In the context of a circular economy framework, industrial symbiosis aims to generate value from waste and improve efficiency of resources by encouraging sharing of industrial byproducts and infrastructures. It sufficiently fulfills the three pillars of a circular economy framework which include: technical innovation based on the exchange of waste products, energy, and resources; collaboration between key stakeholders; and a sustainable business model which eliminates waste by recycling it appropriately (Short et al., 2014). Each of these three pillars is described in detail below:

- Technical Innovation

In the circular economy framework, technical innovation is based on efficient exchange of waste products, such that the waste generated by one industry becomes the raw material for another industry. For example, a chemical company generates large amounts of heat and carbon dioxide that can be provided as inputs to greenhouses to support farming activities (Boons et al., 2015).

- Stakeholder Collaboration

One of the key stakeholders in a circular economy model is the local government or the local municipality that defines the activities that will take place for sustainable development and that provides the seed investment for its implementation. A private enterprise that carries out production processes and generates waste products is another stakeholder that provides industrial byproducts as raw materials. There may also be another enterprise dedicated to maintaining operations, implementation, and coordination of activities to support the circular economy framework. A commercial bank that provides a majority of financial resources for this collaboration may be another stakeholder in the network. Other possible stakeholders include companies that build physical structures to channel waste products from one company to another and local farmers who may use part of these waste products for sustainable farming practices. Each of the above mentioned stakeholders has different priorities and expectations from this collaboration and the complete support of each one of them is essential to make the circular economy model a success (Baldassarre et al., 2019).

- Sustainable Business Model

A sustainable business model encompasses value propositions, and creation of frameworks and delivery mechanisms that take place parallelly throughout the network. The local government aims to improve economic outcomes and create employment opportunities locally. They also provide the infrastructure to support circular economic activities and ease of access to financial resources. Large industries provide waste byproducts for other industries and bear the technical maintenance aspects related to storage and delivery. They also bear the cost of labour required to handle all activities related to delivery of waste products to the relevant companies. Enterprises that supervise these collaborative operations provide the commercial and legal framework to protect the interests of all stakeholders involved. Therefore, every stakeholder contributes to different aspects of the industrial symbiosis network making it possible for smooth functioning of operations (Baldassarre et al., 2019).

### **3. Sustainable Procurement**

Sustainable procurement is defined as a process by which public enterprises procure goods, utilities, and services such that they achieve value for money not only for themselves, but also for the society and economy at large. In doing so, they ensure that they have minimal negative impacts on the environment. Sustainable procurement practices also aim to close material and energy loops within entire supply chains to encourage remanufacturing and reuse of products multiple times. These practices involve building entirely circular supply chains through the use of circular resources, products, and services (United Nations Environment Program, 2018).

Public enterprises that practice sustainable procurement need to ensure that they procure resources within the specified thresholds for resource efficiency levels. This includes efficient use of electricity and fuel in the entire product lifecycle. The enterprises are required to procure materials that have a certain percentage of recycled content and the potential for recyclability and reparability. They also need to ensure that the procured materials or its components have a high degree of non-toxicity as the presence of toxic chemicals can prevent recycling of the resources. Deliberate steps also need to be taken to ensure that the lifetime of the product is extended, so as to reduce the rate of consumption of raw materials and generation of waste products (United Nations Environment Program, 2018).

Several innovative business models have been proposed to support the concept of sustainable procurement for a circular economy. One of these is a transition from product ownership to product service accessibility by encouraging the development of product-service systems. A product-service system is one which not only sells a particular product but a mix of both product and services in order to meet the demands of consumers. Providing leasing or rental services is also a key method to reduce consumption of specific products in the market. Other business models that fall under this category include development of supplier take-back systems based on 'purchase and buy back' contracts, sharing of platforms and collaborative consumption models, providing comprehensive consumer information tools to encourage reuse, repair, and recycling at the consumer level, and engaging in joint procurement processes (United Nations Environment Program, 2018).

### **4. Life Cycle Assessments (LCA)**

The concept of Life Cycle Assessment (LCA) describes the lifecycle of products beginning from the initiation of manufacturing processes until the final production stage. LCA is important because, from an economic perspective, it helps calculate the profitability of an investment in designing and manufacturing a product. In the context of a circular economy, LCA describes the total environmental impacts caused during the lifecycle of a given product. Hence, performing an LCA helps determine those industries and/or products that cause minimal harm to the environment or are most environmentally advantageous during their lifecycle (Szita, 2017).

LCA is a well-grounded tool available to local governments for assessing business models and products originating from a circular economy framework. The ISO14040:2006 standard can be used to assess product development methodologies, the CML 2001 standard can be used to determine both positive and negative effects on the environment, and approaches such as eutrophication, toxicity

assessment, and measurement of acidity potential can be used to measure the effects of the product during its lifecycle. Initially, LCA may be employed for hypothetical testing, based on which it can be used to explore alternative approaches to different product development stages. Organizations subjected to LCA need to make appropriate product declarations through objective and sustainability analyses in order to justify being based in a circular economy framework (Szita, 2017).

## **5. Sustainable Design / Eco-design / Environmental Design**

Eco-design refers to product design and development keeping in mind the environmental, social, and economic effects. It is a strategic activity that helps develop sustainable design solutions that are applicable to every stage of the product lifecycle. Eco-design generally begins with carrying out comprehensive assessments to identify environmental hotspots for a particular product. Based on this assessment, lean manufacturing processes can be designed to improve the energy efficiency of the production processes. For example, if one of the identified hotspots is excessive waste generation at the end of the product lifecycle, then the product design and development processes should aim at making it more suitable for recycling, repair, and reuse (Murray, 2013).

The initial environmental assessment will then inform new and alternative product design and development processes in order to address the shortcomings of the previous processes. It is important that these alternative approaches are realistic and profitable, and can enable collaborative partnerships of the organization with other relevant companies. Once a product is manufactured based on new design strategies, companies can use self-declaration documents to detail out the environmental benefits of the product and its scope for recycling. By incorporating principles of Eco-design in product manufacturing processes, companies can reduce their environmental impacts and encourage the sale of products using environmental advantages as a key marketing strategy (Murray, 2013).

## **Implementation of Circular Economy Models – Case Studies**

### **1. Ananas Anam – United Kingdom**

Ananas Anam is a London start-up that uses sustainable plant-based raw materials to manufacture a textile product as an alternative to leather. The product, Pinatex®, can be used for the manufacture of clothes, footwear, accessories, and upholstery. The company uses waste generated from pineapple plantation farms in the form of leaf fibres to make its product. Pineapple leaf fibres represent only 2% of the generated waste; however, it is the most challenging to treat and dispose. The rest of the waste can be easily degraded thus solving the important problem of waste disposal from pineapple farming. As the product is completely made from renewable sources and is 100% biodegradable, it presents minimal harm to the environment thus upholding the principles of circular economy and sustainable development (Kowszyk and Maher, 2010).

### **2. Better Future Factory – Netherlands**

Based in Rotterdam, Better Future Factory is a consultancy that provides advice and guidance to their clients on how to manage their generated wastes and convert them into commercially viable

products. Their main objective is to close loops in plastic recycling, so that generated plastics can be incorporated into sustainable and recyclable products. One of their first and most significant projects has been converting plastic wastes into personalized 3D printed objects. This venture addresses the problem of plastic waste disposal and makes it an attractive buying option for consumers and retailers. After the success of their first business model, they started another start-up where they began recycling plastic waste into wall tiles that looked like marble. As plastic is one of the most harmful substances for the environment, by addressing the problem directly, this company has successfully endeavoured to identify alternative, more useful, and more profitable approaches to plastic recycling (Kowszyk and Maher, 2010).

### **3. Reimagine Phoenix Initiative – United States**

The Public Works Department of the Arizona State University, along with several public and private enterprises, have come together to establish a physical innovation campus, the primary objective of which is to achieve zero waste within a 30-year timeframe. The campus was set up next to the city's waste processing facility and businesses were encouraged to make use of the waste products and come up with new products that can be resold in the market. The campus also supported research and development activities, attracting companies of all sizes and types to attempt to use waste products for personal profitability as well as contributing to the environment. Until now, the initiative has managed to reduce wastes by up to 30%, create new employment opportunities, and generate profits of 10 million US dollars annually (Climate-KIC, 2018).

## **Conclusion**

Although the response has been a little delayed, several public and private environmental organizations around the world have recognized the need to reverse environmental effects and have taken great strides in achieving common environmental objectives. One of the most important approaches proposed to shift to sustainable development is transitioning from a linear economy model to a circular economy framework. A circular economy is grounded in principles of closed loops of materials and energy, sustainable purchasing and consumption, recycling, waste treatment, and remanufacturing. With the help of several government bodies, many companies have managed to incorporate principles of circular economy in their business models with reasonable rates of success.

With continuous research and development in the fields of resource efficiency and product lifetime extension, several strategies have been proposed to assess existing production pipelines and come up with alternative approaches for product development that fits within the circular economy model. All of these strategies may not be applicable to every industry; however, a smart use of the available tools to implement circular economy in the company operations can go a long way in ensuring sustainable product development.

This article has summarized the concepts of linear economy and circular economy, the limitations of a linear economy model and the need to move to a more circular framework. Several available tools and strategies have been described including recycling, reuse, repair, and remanufacturing; industrial ecology and industrial symbiosis; sustainable procurement through effective

collaborative networks; life cycle assessments that can inform future product development strategies; and eco-design for the design of environment-friendly products and production pipelines. Several companies and start-ups around the world have used the principles and strategies of circular economy for recycling and remanufacturing activities, waste processing and treatment, and eco-design in order to promote the culture of sustainable product development and consumption.

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