

# Chapter 6

## Circular Economy in Materials to Decarbonize Mobility



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**Abstract** Numerous countries have adopted the circular economy concept in their industrial and commercial sectors in order to reduce waste generation. Economic and social development on a sustainable basis requires a focus on material selection during product design and continuous integration of innovation and technology throughout the product's lifecycle. Speaking of our case study, Thailand has shifted its economic and social development model to one that is based on the country's biodiversity and natural resources. Utilizing current technology and innovation will aid in dismantling barriers and propelling forward in order to generate sustainable economic growth. By implementing the Bio-Economy, Circular Economy, Circular Green Economy, And Green Economy (BCG) economic model and achieving zero waste, we can ensure that everyone has a say in how money, opportunity, and wealth are distributed. We can also maintain a balanced resource base and biodiversity by utilizing an integrated circular economy model. This chapter focuses on the circular economy and green economy in an integrated form, in accordance with the United Nations Sustainable Development Goals for sustainable development and the Sufficiency Economy Philosophy's principles of economic development. Thailand's government and society seek to mainstream the circular economy. This report is an integration case study in which, from start to finish, waste, scrap, garbage, and repurposed resources are comprised by leveraging scientific knowledge, technological improvement, and innovation to create added value. Scholars can use a

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wide range of resources to help solve environmental problems in a different way that can also be good for the economy. This report is an integration case study from start to finish, waste, scrap, garbage, and recycled materials comprised by leveraging scientific knowledge, technological advancement, and innovation to create added value.

**Keywords** Mobility · Decarbonize · Green economy · Sustainable development

## 6.1 Introduction

The world's population growth is unabated, as is economic growth. As a result, the world's population continues to grow, necessitating the use of natural resources to manufacture consumer goods. Consumption demand increases proportionately. However, due to the natural resources that are primarily utilized, this is a finite resource that is rapidly depleting, both in production and consumption, resulting in significant waste or garbage. Globally, business organizations are aware of the situation and issues at hand and understand the critical nature of utilizing available resources in the most cost-effective and efficient manner possible. Additionally, the waste generated by a portion of consumer waste can still be recycled. As a result, the world's ecosystems continue to degrade. The efficiency with which basic resources such as biomass, metal, non-metal, and fossil energy are used remains low in Thailand's economic development. Numerous resources, including low productivity, soil, water, degradation, and quality degradation, are impacted by waste management efficiency. The social cost of addressing pollution and its consequences continue to rise, and there are few innovations and technologies to support the transition to a circular economy or existing technology (e.g., environmental insights, material flow analysis, life cycle assessment, and indicators of energy efficiency). Attitude and behavioral changes on the part of producers and consumers recognize that garbage or waste is still a renewable resource if it is separated, stored, rotated, and used properly. The benefits include increasing manufacturers' and consumers' acceptance of circular economy-related products. It will contribute to the development of a circular economy and the reduction of market volatility. Thailand has a total of 29 million tons of solid waste generated by its communities. In addition to recycling, which generates greenhouse gases and contributes to climate change, smoke, hazards, marine debris, and improper waste disposal, open-air burning, particularly of rice fields, has a detrimental effect on the environment and human health. Contribute to the ecosystem's health (Information on Waste Management in Thailand [Online] Wikipedia. <https://en.wikipedia.org/wiki/WastemanagementinThailand>. Accessed 25 May 2021). Thailand's economy is transitioning to a circular economy model by creating value worth less than three billion USD in 2017 (Information on Waste Management in Thailand [Online] Wikipedia. <https://en.wikipedia.org/wiki/WastemanagementinThailand>. Accessed 25 May 2021). Pressure or constraint acts as a catalyst for the development of recovery capacity, resulting in resource conservation, restoration,

development, and enhancement, including resolving pollution and environmental issues through an emphasis on resource management and manufacturing factors.

An economic system that is circular is an economic system in which the production system's resources can be planned, restored, and reused. To address future resource shortages, resource recovery can take the form of utilization in a variety of fields, including adding value to the material (Information on Waste Management in Thailand [Online] Wikipedia. <https://en.wikipedia.org/wiki/WastemanagementinThailand>. Accessed 25 May 2021). The European Union recently announced the "2018 Circular Economy Action Package," which includes objectives and policies aimed at reducing plastic waste, reducing landfills, and increasing recycling. This demonstrates that governments and businesses around the world are actively promoting the circular economy. Thailand places a premium on the country's development toward sustainability and the transition to a circular economy. People in the government want businesses to use the "circular economy" concept in their work, and they want them to do that by setting up a "Strategic Plan for Building Growth with an Environmentally Friendly Quality of Life" in the 20-year National Strategic Plan (2017–2036).

Thailand has shifted its economic and social development model to one that is based on countries' biodiversity and natural resources. Contributing to the enhancement of value throughout the chain of goods and services production. Utilize modern technology and innovation to assist in breaking down barriers and taking a leap forward in order to generate sustainable economic growth. We can achieve clear participation, universal distribution of income, opportunity, and wealth, and the maintenance of a balanced resource base and biodiversity by implementing the BCG economic model and zero waste production. It is a development that is environmentally friendly and sustainable. "B" stands for "bio-economy," and "C" stands for "circular economy." "G" stands for "Green Economy." Thailand is trying to promote the BCG Model as a global climate change agenda in the spirit of one world, one destiny. A Single World, a Single Common Vision Thailand can then respond to the global community.

This report focuses on the circular economy and green economy, in accordance with the United Nations Sustainable Development Goals for sustainable development and the Sufficiency Economy Philosophy's principles of economic development. Thailand's government and society intend to mainstream the circular economy.

Adopting a circular economy as a "New Economy Model" or BCG Economy (Bio-Circular Green Economy), a sustainable development economic model, is a holistic economic development strategy that will simultaneously create a 3D economy composed of three distinct economies: B stands for Bio-Economy, which is a bio-economy system centred on cost-effective bioresource utilization. The government has designated the BCG Economy as the country's driving strategy for the years 2021–2026 in order to lift Thailand out of poverty. The circular economy is also recognized as a means of economic recovery following the outbreak of COVID-19, as it contributes to the creation of products and materials with value.

## 6.2 Intelligent Product Design

It consumes fewer resources (Smart Design: Fewer Resources) and has a longer useful life (Extended Product Life), thereby reducing global waste. Used products must be repurposed, as well as the sharing system promoted (the sharing economy). With an increasing reliance on domestic production and consumption (local consumption), recycling is a critical industry for Thailand because it is interconnected with the production of other industrial sectors. Although the market is worth more than four trillion baht, it must be adjusted to meet the needs of lower production costs, energy savings, and minimal environmental impact. This is a critical industry that we must advance. As a result, the indicators are highly valued and in constant demand by the market. The government has pushed for a circular economy in the industrial sector. The Ministry of Industry has placed a premium on the government's development policy. Simultaneously, the BCG economy encourages private sector investment. Also, the industry of scrap recycling is being promoted. This results in a reduction of long-lasting pollutant emissions and reduces industrial waste generation by repurposing it in a way that adds economic value. Collaborate with relevant agencies, such as the United Nations Industrial Development Organization (UNIDO), Pollution Control Department, the Department of Environmental Quality Promotion, the National Research Office of the Ministry of Higher Education, Science, Research, and Innovation, and the National Science and Technology Development Agency, as well as scrap recycling entrepreneurs.

Since the Industrial Revolution, the waste of wealth has been a major global driver. Even now, there is a greater variety of raw materials available. However, renewable resource use remains an indispensable raw material. It is the fundamental raw material used in the manufacture of a large number of series products, such as automobiles. Industries include construction, agriculture, energy, services, and packaging. It is a vital sector of the Thai economy. Additionally, the industry is critical because it produces and exports to a large number of countries. There is tremendous potential for a circular economy all around us. It is a critical mechanism for Thailand to develop and improve its national, regional, and global competitiveness. The BCG model plan for a National Agenda for Sustainable Economic Development aims to propel the country forward by increasing the value added along the production chain through the application of modern technology and innovation. The BCG economic model is the engine that propels inclusive growth in the country. Concurrently developing the economy with social development and environmental preservation in a balanced manner in order to achieve stability and sustainability is economic development throughout the value chain. This is accomplished by transforming the advantages Thailand has derived from biodiversity and culture in order to compete with innovation on a global scale. This includes the application of creativity to enhance the value of products made from recycled materials, as well as the application of knowledge to increase production efficiency. It is important to pay close attention to an environmentally friendly production system and production measures that adhere to international standards. Upgrading products through innovation and

transforming them into high-value products can result in a price increase of up to doubling. This lengthens the supply chain, resulting in increased income distribution to the community to alleviate inequity and build community and growth that evenly distributes income, opportunity, and wealth.

Forces both within and without the nation Several disciplines' technologies are merged. This led to further development to create a structure for collaboration between communities, the governmental sector, the corporate sector, and financial institutions. Educational institutions are beginning to give easy-to-use technologies for occupations and enterprises, as well as the utilization of resources and waste materials for manufacturing and usage, leading to increased income while conserving ecosystems and the environment.

Individual research project funding should be supported. Improve industrial sector human knowledge and skills to enable global technological progress Creating and linking cluster networks of professionals and firms in the manufacturing and processing industries. Continuous product development research Various agencies are tied to standardized factory selection prototypes.

It is necessary to provide research assistance, raw material production, and acquisition for educational institutions and the private sector to enhance the industry's growth to ensure its long-term competitiveness. When building a new strategic industry, it is best to stick to the current industry.

Relationships of Thailand with the International Community Adopt foreign technologies, sustain dual circulation, and grow domestically. Promote originality while fostering self-reliance and discipline. Entrepreneurs in the group are involved in innovation and originality. Developing a new economic system Create a new market through privatization and Increase producer and consumer adoption of circular economy products, hence mainstreaming the circular economy in society. The BCG Economic Corridor must be distributed among all regions.

Developing and improving products is derived from a variety of resources by enhancing their quality and creating solutions that provide discarded materials with extra value. Developing standards for recycled materials or products from the application of waste to fulfil the requirements of the new market in terms of quality and safety in order to assist in analyzing, testing, and certifying quality product performance and registering and promoting products. To facilitate the expansion of both domestic and foreign markets, we must provide an ecosystem that encourages private sector investment in supranational development.

For the operation to have a chance of commercial success, private sector participation is essential. Advancing Thailand's progress toward the Sustainable Development Goals by establishing a brand with added value needs to:

- Utilize Insufficient resources for a country's development. Adopting the economic idea to attain objectives.
- Utilize resources to generate economic value.
- Connect products made from recycled materials to new alternative resources.
- Improves existing skills, upsills, reskills, or acquires a new skill.

- Necessitate supporting the reorientation of the Thai economy toward the production of innovative goods and services by encouraging the emergence of entrepreneurs, particularly in innovation-and creativity-related organizations.
- Promote access to funds and markets for items made from recycled materials, as well as product registration, product performance studies, and market introduction.
- To achieve user acceptance and compete with imported products in order to increase the likelihood of entering the international market, it is necessary to create an ecosystem to support the development of new industries in terms of infrastructure promotion measures and to remove obstacles to the expansion of the recycling industry.
- Constructing a production platform on an industrial scale is important.
- Unlock restrictions on investment by utilizing fewer resources and fostering a sustainable society; the circular economy contributes roughly \$4.4 million to world economic growth.

Thailand is in the midst of shifting to a value-centred circular economy. It affords the nation a cost advantage and permits humans to coexist with nature. Promoting sustainable manufacturing and consumption increases profits and creates jobs. In the next ten years, it will contribute at least 200 billion THB, or 1% of GDP, to the country's economy.

### **6.3 Concepts, Theories and Related Research**

A Circular Economy (CE) is an economy that is circular by design. To address the situation, it is possible to restore and reuse all production resources. Future resource scarcity will necessitate an increase in production resources as the economy grows and consumer demand for goods and services rises. As a result, the circular economy prioritizes maximizing the duration of the product value. Encourage reuse and prioritize the management of production and consumption waste by reusing previously produced raw materials in a new manufacturing process. In contrast to the linear economy, in which large quantities of natural resources are extracted before being used in the manufacturing process and sold to customers, the circular economy involves the extraction of natural resources, their use in the manufacturing process, and their sale to customers. When a product has outlived its usefulness, it is discarded as garbage.

## 6.4 Definition

### Scrap Chain

“Product scrap” refers to a product that has been damaged or degraded to the point where it can no longer be used or desired. A business that is registered with the Pollution Control Department or a local government agency is referred to as a “residue collection facility.” collect product remains from consumers or those in possession of scrap products, or a collection network for the product remains. A “products disassembly facility” is defined as a factory that has been granted a license to operate a sorting business under factory law or a sorting business establishment that has been authorized under the public health law and registered with the Pollution Control Department. Soil or rubbish.

The term “importer” refers to the owner or possessor of electrical and electronic equipment products from the time they are brought into the Kingdom; “manufacturer” refers to the owner of a brand or trademark on electrical products and electronic equipment. If no brand or trademark is present, the manufacturer is assumed to be the person listed on the label or the name on the label, and it is assumed that the inventor assembles or acquires the product.

The term “product collection network” refers to an individual or organization. Corporations, foundations, non-governmental organizations (NGOs), and other organizations (provide services for the return of product remains to a scrap collection site from consumers or those in possession of waste products). The circular economy focuses on waste management and waste resulting from the consumption of goods. It is a system that utilizes resources in the most effective manner possible. Return used goods to the manufacturing process (Make-Use Return) for balanced business growth, improved quality of life, and a sustainable global future. The concept of the circular economy is founded on nature-inspired innovation. Environmental design concepts are based on a process-based approach that follows the product’s life cycle (Bio-mimicry). From the pre-production to the post-production stages, As a “natural” model or Cradle to Cradle design, the circular economy is a waste-free production system based on natural principles (C2C). Due to the fact that one company’s waste will always serve as a source of raw materials for another, reuse and recycling will be the most crucial aspects of this economic system (Özkan and Yücel 2020).

## 6.5 Circular Economy and Scrap Metal Recycling Industry

There is research on the factors that affect circular economics and environmentally responsible behaviour. The environment of scrap metal recycling companies in Thailand is analyzed using a structural equation model (SEM) to determine the causal relationship between variables from previously studied studies (Akkalatham and Taghipour 2021). The variables used in this study to analyze the behaviour of the

study targets, namely foundry parts, were selected based on the responses of stakeholders in the manufacturing and management industry chain (Taghipour et al. 2022). It was found that respondents valued long-term relationships with product manufacturers (suppliers) and business partners and that quality control had a substantial impact (Taghipour et al. 2022). The ability to meet customer needs while using the fewest resources possible in production can be produced in accordance with the number of customers' required time frame as well as the best quality and price. The cost of recycling and the cost of recycling was discovered to be comparable. Environment awareness has the desired effect on perception and behaviour regulation. As a result, it is essential to educate the public on the circular economy and its principles. The study also demonstrates that the intention of a society to recycle has the greatest impact on the circular economy's implementation and outcomes. The confidence of all sectors is the most influential variable in a circular economy. Encouraging collaboration in the implementation of the circular economy concept. Numerous factors are required in order for the steel industry to successfully implement a circular economy. The most obvious is society's willingness to recycle and adopt lean production systems, protection of behaviour, and environmental stewardship. via convictions and attitudes (Akkalatham and Taghipour 2021). Additionally, it increases production capacity to aid in the growth of the nation's economy, and the circular economy concept must be aggressively promoted. The circular economy is a future business model because there are environmental and economic benefits to doing so, as it is depicted in Fig. 6.1 (Akkalatham and Taghipour 2021).

According to Donati et al. (2020), the addition of steel and aluminium to the production of parts would result in a 28% reduction in raw materials. It is believed

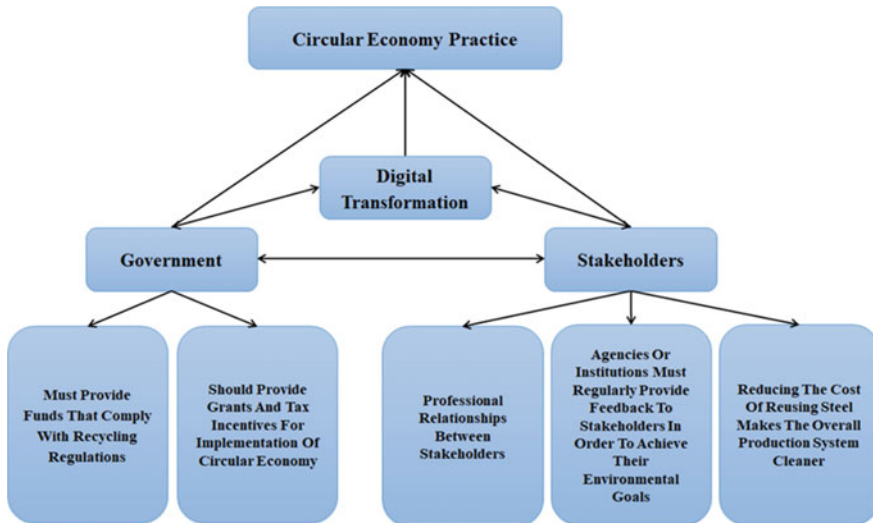


Fig. 6.1 Circular economy practice (Akkalatham and Taghipour 2021)



that the use of instruments, machinery, and electrical equipment enhances all production (Mahapornprajak 2019). Doubling from the industrial revolution due to mechanization, mechanical engineering is the most diverse of the engineering sciences (Schwab 2017). The indicators demonstrate that reducing manufacturing waste has a positive effect on the environment. This approach is based on the assumption that 35% of steel and aluminium products from semi-finished products is transferred to other uses, despite the fact that the socioeconomic analysis yields negative results (Tsai et al. 2019). Fewer scrap metals remain, and as a result, machine knowledge is being transferred across industries (Maloutas 2015). For example, in the construction industry, up to 90% of steel and aluminium scrap can be recycled (Allwood and Cullen 2015), leaving only 7% in production lines and industrial plants. Therefore, we believe that promoting recycled materials is the correct action to take.

In 2018, production costs increased globally, comprising 66% of total production costs (Donati et al. 2020). Both scrap metal prices and imports of raw materials have recovered. Products made of steel that have reached the end of their useful lives will be recycled and reused. In the new melting technique, the chemistry has changed. Superior to metal in distinction, Magnets contribute to the recycling process by removing contaminants such as plastic, brick, stone, mortar, sand, and metal from steel, among others. Consistent with the circular economy principle of zero waste, the reusability of the properties has a significant environmental impact. These guidelines will help you reduce waste at its origin (Japan Iron and Steel Federation 2019).

## 6.6 Guidelines for the Circular Economy in Thailand

Responsibilities for Solid Waste Management in Thailand, the local government's waste management system oversees all aspects of waste management, including raw materials, production, storage, transportation, use, and disposal. According to Parinda and Sirawan, the amount of recyclable waste generated in 2018 was approximately 27.8 million tons. 8–9.5 million tons of benefits, 10.8 million tons of properly managed waste, and 7.36 million tons of improper solid waste disposal resulting in environmental and public health problems. In addition, there is currently no production control system for waste disposal processes or waste management. The production line is neither the responsibility of the user nor the importer. Consequently, recyclable trash is discarded. It is combined with domestic garbage and discarded without classification (Sakolnakorn et al. 2016; Ghosh 2020). Large heaps of trash (gravel) with no way to return to the original site. Along the way, it releases a great deal of pollution into the water, soil, air, and living things. When more raw materials are needed, we must continue to extract new resources from nature until our current resources are nearly depleted. Approximately 57% of municipal solid waste collection and disposal is only 7.88 million tons, including incinerators with air pollution control and the construction of a waste disposal centre, or 53% of the total waste collected. An estimated 47% of collected waste, or 6.93 million tons, was disposed of at landfills. Eliminate everything in mass. The remaining 43% of waste is not collected

by the local government (Toomwongsa 2017). 6.53 million tons of waste per year or 13.5 million tons of waste dumped illegally (Somboonwivat et al. 2018). There are still no waste management regulations in place. As well as participants' long-term planning for the start of the waste management procedure (Tangwanichagapong et al. 2020). Environmental Control and Pollution Control Plan for 2012–2016 outlines the nation's waste management objectives (Ghosh 2020). A study of waste management methods and policies reveals that consumption and production patterns are not used creatively, which can be quantified as a company's ineffective use of waste and resource management methods. Initial policy and administration are required. In addition to behavioural modification, Initially identified and modelled as an "industrial system of awareness and creatively designed for revitalization" (Lewandowski 2016), the circular economy entails exploring and creating opportunities for change in accordance with the Cradle-to-Cradle methodology. The circular economy will prioritize waste-free product design, the use of renewable energy, and respect for local communities and ecosystems in order to promote recovery. Toxic substances must be disposed of properly, and waste must be recycled, which must end to a better design of materials, products, systems, and business models (Özkan and Yücel 2020). Emerging as a new paradigm for resource management, energy generation, and value creation is a circular economy. Creating Employment to Develop a Business Explain why it is necessary to utilize multiple business structures in order to maximize overlap and benefit. Linder and Williander (2017) define a circular business model as one in which the principles of value creation are integrated throughout the business sector's product lifecycle. From the manufacturing process to the consumption of new raw materials, this new cyclical pattern has been transformed into Make-Use-Return, which aims to produce (make) products utilizing as few resources as possible through innovation and design (Pongpiachan and Apiratikul 2021). Then, utilize the product to its maximum capacity and dispose of it properly so that the materials can be reused in the new manufacturing process. Mentink (2014) defines CE as a "closed-cycle economy of materials" and "the impetus for its development." procurement and measurement within the closed material circuit.

## **6.7 Strategies or Strategies for Decarbonizing Solving Problems or Development Guidelines**

Innovativeness and technological progress improve our world by fostering collaboration in multiple areas through agency or hyper-collaboration (public–private people partnership) that spans the dimensions of space, people, and products, utilizing innovative technology to aid in the manufacturing, processing, distribution, and product management processes along the supply chain. The ability to strike a balance between production and marketing creates value. Both productivity and product quality are increasing. Developing and Integrating Expert Clusters Entrepreneurs and networks shift from operating independently to cooperating and joining forces. The industrial

sector and the nation's economy are expanding in a sustainable manner, and the government plays a crucial role in assisting the industrial sector in recycling raw materials. The COVID crisis serves as a significant global catalyst for the "Management of production of zero waste.". The desire to utilize unlimited resources is the result of economic and social growth (van Eijck et al. 2014). How to achieve zero waste through recycling materials Modern education, incorporating science and innovation, has been transformed into an economic system. The creative economy and the new value creation economy emphasize both quantitative and value-added productivity in order to recycle value. A diverse range of goods It is used in conjunction with technology and innovation to fit the modern world economy and society, with the goal of creating both short-term and long-term benefits; the short-term goal is to reduce costs and increase profits, while the long-term goal is to enhance community and environmental well-being and safety. Environmental innovation is the extension of the four innovations and the implementation of original concepts (Wang et al. 2020). These types include products, processes, services, and business models designed to develop and enhance management. Manage the corporate environment by engaging in activities such as product development, recycling, and product enhancement.

## 6.8 Decarbonization Strategies

- Efficiency (efficiency) outcomes that are in line with the productivity target the same employee is more productive or produces superior results.
- Making the most of limited time and financial resources. Taking "value for money" into account.
- Low cost, no leakage, less yield loss, and lower maintenance costs.
- Engage in a variety of activities by converting scraps into valuable raw materials, "zero waste" means there is no waste wasted or waste that causes pollution and danger.
- Wastes can be converted to new alternative materials, thereby increasing efficiency, decreasing costs, reducing pollution, enhancing sustainability, and preparing individuals for the future.
- Empowering human resource development is the most valuable asset, transferring knowledge from each entrepreneur's direct experience in that field, combined with research studies, technology, and innovation trips from abroad, in order to reduce skill gaps.
- Information on the skills, competencies, and knowledge required of personnel for operation, as well as information shared with partners. Hence, the best way to learn is by doing.
- Utilizing the resources of each individual, conducting value analysis and value engineering, and creating new innovations.

These strategies can be used together, which is important for the success and growth of knowledge exchange over time because it lets people meet each other's needs and help each other.

## 6.9 Enhance Competitiveness

- Instead of strengthening the internal economy and integrating it into the global economy, the country's growth should be influenced by external influences.
- Establishing guidelines for recycled materials based on their environmental impact. Reduce product registration procedures to enhance consumer confidence (recycled content of secondary materials). EPR specializing (Extended Producer Responsibility). The foremost authority on the formation of a circular economy in the United States.

From the shelf to the shopping mall, Integrating research and development with business (Research to Industry Convergence) In accordance with the government's aim to promote research and innovation through collaboration, we are supporting collaboration. The government has built an ecosystem that encourages the private sector to invest in the development of a higher quality than the state, so encouraging the private sector to become the principal investor in the private sector. To construct a new strategic industry, the economic development of the old sector must be modified. Modifying grant money for particular research projects to research funding From research and development through production and distribution, the sector is at the forefront of technological and intellectual innovation. Developing and adding to product and service value Increasing receptivity to world-changing currents and rising technological autonomy Government, commercial sector, community, society, universities, research institutes, and worldwide networks share four features. Transform Thailand's diverse advantage into a competitive edge. Initially, the research effort failed to match entrepreneurs' actual requirements. Consequently, the project was concluded. To develop implementation recommendations for linking research results that meet requirements. Increased investment or joint ventures can also benefit entrepreneurs or industries. In practical initiatives, academics, researchers, and faculty members leverage private-sector research. Entrepreneurs and students from across the nation engaged in the project coordinated by the research office. NATIONAL and the Department of Industrial Promotion collaborate on research with the commercial sector to increase public understanding and address societal concerns. Increase Thailand's competitiveness by increasing its waste disposal capacity. By allowing entrepreneurs with superior expertise and technology to invest in waste management enterprises, we are fostering innovation and entrepreneurship. Increased interchange, learning, and network building in the field of research boost competitiveness. Increase the likelihood of expansion. This enables the production of more diverse or creative goods and services, hence enhancing sustainability (Lunkham 2019). Natural resources and environmental development. It assists in behavioural

change. Reduce waste at the household, office, and community levels and separate trash. Education is essential for promoting and enhancing the quality of life of a country's population in order to keep up with changes in society and the global community; it is a vital component of the nation's development. The laboratory research is ready for pilot production, factory production, prototype production, and industrial production. The recycled products contribute to the economy by meeting market demands and boosting national competitiveness. The university will successfully employ its knowledge, skills, and potential within strategic groups in which it possesses the expertise on an international scale. University competition is a critical growth engine for the nation; thus, it should be encouraged. The objective of training a new generation of BCG and circular economy researchers is to improve the community and future generations' resource management.

## **6.10 Guidelines for Driving into Action**

Through innovation and creativity, BCG Economic Policy and Sargent's Project Action Plan provide examples of waste materials and waste that add value to the manufacturing and service sectors. By separating contaminants, this novel process improves the quality of scrap and waste. In short, it can transform the conventional business model. However, it must also be used in conjunction with a variety of business models to achieve long-term efficiency. The business model of the circular economy is based on the principle of "creating value" by radically altering the traditional economy. Change the structure of the economy from a labour-intensive nation to one that produces goods and manages innovations, becomes self-reliant, and transforms into a developed nation. To reduce the cost of imported technology, the factory produces innovative products while taking environmental costs into consideration. This report is a pilot application of innovative technology as a model for increasing efficiency, decreasing pollution generation and emissions, and making the production process extremely environmentally friendly. Circular economy practices are more important than the 3Rs: Reduce, Reuse, and Recycle and zero waste, but at its core is a redesign, which is rooted in "design thinking" that comprehends the societal pain. According to the national development strategy, SMEs, startups, corporations, large publicly traded companies, the community, employees, educational institutions, and research and innovation personnel of all sizes, both public and private, are encouraged to participate. Recycled materials are a renewable resource. Creating a new generation of society with knowledge, attitudes, and conscience that takes into account the efficient use of resources, value for the quality of life, and a good environment requires the separation of storage, circulation, and use, as well as the acceptance of circular economy-related products by manufacturers and consumers. Establish and utilize a second round of raw material collection or exchange centres. The secondary raw materials hub creates an infrastructure for the disposal, sorting, and recycling of biodegradable waste into secondary raw materials. Create a learning centre and a database of flow information. Both waste and raw materials are included

in recycled materials. Develop market mechanisms that are suitable and incentivized to induce change and reduce the type, type, and diversity of recycled materials. The design and development of products derived from waste or byproducts. With certification labels for the circular economy, waste can be linked to capital market instruments and financing to facilitate entrepreneurs' access to capital for business transformation. To construct a platform Services for online sharing and exchange of knowledge, The national and international public and private sectors should collaborate on circular economy news. Enter the recycling business with the policy framework, the control of in-situ pollution in the recycling industry, and the provision of subsidies for innovation-related businesses in the scrap metal industry are all interconnected. 89.5% of governments or institutions conclude that professional relationships between stakeholders are essential and should encourage their development. To achieve these goals, implement environmentally responsible production. As part of its efforts to protect the environment, the government should educate the public on the significance of recycling. Environmentally responsible sorting procedures Both the public and private sectors contribute to the cause's support. A comprehensive examination of 89.6% environmental friendliness Reducing environmental impact through recycling clean scrap separation from other materials prior to melting the product that generated the least amount of production waste, 93.9%, clarified that the decreased cost of recycling strengthens the overall production environment. Increased by 91.1% it was discovered that the use of the green branding environmental protection seal was associated with a These products are brought to life with the aid of environmentally friendly goods and services. Reducing environmental impact is the objective of creating a green society in the future. 84.8% of steel importers and exporters stated that globalization increased the complexity of small-scale industries, and 89.6% agreed that implementing circular economy principles would increase product efficiency. 95.5% of respondents agreed that an online marketplace should exist. On websites where interested individuals can access information, users are interested in the information. Recycle rapidly. The Internet will become the hub of commerce that can be reached rapidly and fulfil the purpose of promoting trade and waste disposal to truly aid in the elimination of waste.

## 6.11 Summary and Recommendations

The recycling industry contributes over four trillion Thai Baht to the national economy and continues to grow. It creates enormous career opportunities for Thais. Creating Creative ecosystem businesses is the engine that propels economic growth. Since the Industrial Revolution, it has been the world's primary driving force. Nevertheless, despite the fact that there are more raw materials available today, it is still an indispensable raw material that cannot be eliminated. However, production costs must be reduced to meet demand. Technological progress is a catalyst for the formation of adaptable new businesses and returning to the original challenge of creating new opportunities and alternatives to change. Transforming problems into business

intelligence, having the foresight to deal with the future, maintaining an open mind, and being creative are characteristics of business intelligence. The learning exchange enters the industrial revival period. Natural degradation and more severe environmental issues, such as the problem of solid waste management, environmental pollution, contamination, improper sorting, and recycling, are largely caused by unclean leftovers. It will lead to polluted combustion, which will negatively impact the environment and public health. As a result, a sustainable recycling enterprise is being established, which can help reduce the amount of trash that must be destroyed. Recycling reduces waste production, and this also requires less energy than the production of new raw materials due to the lower melting point of waste materials. Recycling can also help reduce water and air pollution and aid in reducing water pollution, which consequently contributes to small business owners' income generation. Moreover, health concerns necessitate environmental remediation, which in turn necessitates modification. There is social pressure to adopt greener production methods (Suksabai and Tuprakai 2020). To bring Thai industry standards up to international standards, waste needs to be managed in a safe and efficient way. To make the factory eco-friendlier, materials need to be used more efficiently, and waste needs to be cut down. A healthy society cannot be purchased. Want to assist? Environmental innovation consists of the application of novel concepts and the development of new products. Products, services, processes, and business models are the four major classes. The creation of green products with added value and recycled products is a component of management enhancement and corporate environment enhancement from the design phase through purchasing, hiring, and production of technology applications with added value. Under current regulations, comprehensive waste management is required to prevent the release of pollutant-causing substances. The international standard recognizes innovation and the application of systems and tools for quality management. Environmental security is improved by investments in pollution-reduction technology innovation. By replicating the success factors, the overall profitability of the chain is increased. This contributes to the improvement of the quality of the production line. The emphasis should therefore be placed on innovation by modifying the innovation production procedure. So, new processes designed to maximize benefits in the BCG Model Recycling Industry's Supply Chain Raw Material Preparation prioritize the use of materials that are clean, safe, and less wasteful. Adding value distinguishes products and is not constrained by differentiation, operation speed, or adaptability, which means that the invention of new alternative industrial materials results in a product that cannot be replicated, even if it is technically feasible to do so. Furthermore, the consciousness of the significance of environmental management alongside business expansion, fortifying factories to save the world, minimizing dust, and continuously conserving energy. Also, employees must be educated on the significance of innovation and technology. Promoting the efficient use of resources and a positive image creates an advantage for the organization in terms of reducing costs associated with raw materials, energy, and pollution treatment. Additionally, the organization and surrounding communities benefit from conservation efforts.

The recycling industry implements “best environmental practices.” Measures must be implemented throughout the supply chain to reduce emissions. Inadvertent emissions of persistent pollutants from waste recycling centres and businesses reduce industrial waste generation by reintroducing production in a manner that adds value. Sustainable development goals (SDGs) The Sustainable Development Goals are a comprehensive set of development objectives established by the United Nations and encompass nearly all aspects related to the quality of human life. Greenhouses from waste recycling centres and businesses by the issue of SDGs related indicators. The recycling industry is characterized by inclusiveness, full employment, and sustainable economic growth while building infrastructure to support change, promoting sustainable patterns of production and consumption and accelerating action on climate change and its consequences. The creation of a policy framework, guidelines, and instruments must include regulatory and control measures that lead to pollution remediation. Regional information linking and development province by province Utilizing incentives and economic measures as opposed to legal and awareness-raising measures, there exists a structure that can be scaled up by industrial plants based on their power output. By establishing a budget-supported development fund for entrepreneurs with limited income and expenditures, the government can support a sustainable green industry. The government can consider tax deduction incentives for entrepreneurs willing to invest in pollution reduction. In addition, the government may offer low-interest loans for the development of technology and assist companies in securing financing from the World Environment Agency.

To inform the public, stakeholders, and operators, the government should collect and disseminate reliable, consistent, and accurate data in accordance with applicable laws and disseminate information to the public via its website and various social media platforms. The government must incubate and seek out innovative technology in Thailand’s recycling industry, compile a list of Thai inventions, and fund research to add items to the list. Aside from that, they must increase quality, the capacity to list innovations and funding for constructing a networked BCG technology enterprise. Opportunities for promoting sustainability must be generated through business ventures and innovation subsidies that allow entrepreneurs to reduce fuel costs. In addition, these practices reduce the release of toxic substances into the environment and contribute to the enhancement of BCG’s image in the country, which is an additional factor in attracting investment. Consequently, the economic growth of medium-sized cities within the metropolitan area is of greater significance. It is a significant force in the development of sustainable cities and human settlements and plays a vital role in urbanization. The sustainable business model can create a system for managing air quality that is efficient and effective.

Building infrastructure and utilities in accordance with the plan to increase a country’s competitiveness stimulates production and strengthens its ability to carry out missions effectively. Its purpose is to enhance production, service, and asset management by applying technology and innovation. For urban and economic development, the region must diversify its investments. To increase competitiveness, international cooperation must be promoted. To facilitate cooperation between polluters and communities, participation from multiple sectors, the development of network



partners, and the empowerment of entrepreneur projects are required. In order to provide change incentives, the organization must establish a sustainable development working group comprised of public, private, and local stakeholders in the region where it operates. Similarly, academic collaboration with colleges, universities and government agencies is required to create a database to store placement data and training and evaluation plans. There is a quantifiable number of pilot area projects, pilot activities, and demonstration activities at the circular economy factory waste management centre entities with the motivation and readiness to act. The government coordinates factory operations in accordance with the standard for the green industry. By providing a training course, a discussion forum, and technical support, we can help reduce the linear economy practices.

## 6.12 Case Study

Innovative building materials It engages in product life extension, green cement production, and circular supply. The government recognizes the significance of government market innovation growth. The objective is to achieve supply and demand equilibrium (Egbaria et al. 2020; Fan and Fang 2020). A report on Thai innovation has been compiled as a result. Innovative reverse engineering mechanisms and functional structure discovery techniques enable the commercial production of goods and services with internationally comparable specifications and standards. Before constructing a new device or system, it is necessary to analyze the operation of an existing device or system. A new device that functions identically without copying the prototype results in a product that is superior to the original by avoiding flaws and enhancing the strengths of the original product. New businesses generate marketing opportunities and stimulate economic growth (Liang et al. 2020; Mahat-tanalai 2019; Wijayasundara 2020). The country's circulation increases the likelihood that people in the region and rural areas will have access to technology. Enhancing stability and self-reliance and fostering the growth of human capital that generates employment. A nation's economy is sustainable when it is able to export products that are competitive on the international market. The new economy promotes economic growth.

With a business, This facilitates the production and addition of value to waste materials. The National Science and Technology Development Agency Ministry of Higher Education, the Science Research and Innovation Office Ministry of Industry, and the Thailand Industry Council are among our collaborators. The Department of Industrial Promotion Office of the Board of Investment Budget Office of Industrial Product Standards Department of the Comptroller General Concrete is used in the construction industry where reinforcing steel is used (reinforcement) of a log, grate, or is embedded within. It possesses a remarkable compressive strength. However, it is delicate when tense. Therefore, steel, which has a high compressive and tensile strength and the same coefficients of stretch and shrinkage as concrete, is employed so that the two materials can provide mutual support. The iron will act as a tensile

load, while the concrete is compressible; this material is commonly referred to as reinforced concrete (reinforced concrete). In addition, the use of reinforcing steel is permitted can also help reduce the size of a column or beam without diminishing its strength. Round bars, steel re-rolled round bars, deformed bars, steel wire strands, and high tensile steel wire for pre-stressed concrete are the five most common types of reinforcing steel. Strong Tensile is to create a prototype of social innovation and technology for waste reduction, and a paradigm shift is used to analyze the transfer of new knowledge and technology in order to locate a prototype.

Sustainable waste management is integrated by Utilizing information from other fields in the industrial sector Absorption of foreign technology, also referred to as interdisciplinary cross-species knowledge, amplified the impact of material innovation until the emergence of a new body of knowledge integrating interdisciplinary technologies. Reduce the use of minerals in material science (Economic and Social Commission for Asia and the Pacific (ESCAP) 2021). Combine virgin and recycled materials to create secondary raw materials. The technologies of robotics, energy storage, and modular design reduce expenses, resources, and environmental impact. Contributing high-quality research to the body of national knowledge. Utilize design to increase the value of the product. Slowing the generation of waste by increasing the value of leftovers extends their lifespan and transforms them into something other than waste, such as reducing their use in the creation of new products in accordance with green industry and zero emission standards or business continuity models. Using circular economy and intelligent networking, an integrated model for waste management will be created.

This social and urban development included the emergence of special economic zones to develop new industries to meet future needs, which led to a substantial increase in construction. Due to the high proportion of steel fibre usage, developing a model for using recycled steel fibre to replace steel fibres is an intriguing aspect of the commercial development process. Bio-Economic Development-Circular Economy-Green Economy (Bio-Circular Green Economy—BCG Model) has as one of its tenets the reduction of natural resource consumption and greenhouse gas emissions (Apisitniran 2020). The concept of reusing waste materials to reduce iron ore imports and the consumption of new resources is known as recycling. In addition, it adds value to scrap materials to reduce costs. The BCG Model is reflected in the guidelines for construction. By giving it a new purpose, reusing steel fibre in reinforced concrete will benefit both the economy and the environment. If it can be used commercially, it must conduct an experiment to compare the properties of various types of reinforced concrete and document the results as a guideline for the creation of a standard for the use of recycled steel fibre in reinforced concrete in order to achieve the set objectives.

Better load-bearing capabilities. Steel fibres with a higher utilization rate aid in extracting maximum efficiency. Utilizing the floor increases its capacity to withstand greater loads. Utilize the optimal area thickness. Steel fibre contributes to the suitable and durable thickness of the area.

Reduce the construction duration. The use of steel fibre for reinforcement shortens construction time and reduces construction expenses.

It requires less density than flooring reinforced with rebar.

Wire derived from worn tires The bead wire and plied cord extends from the tire's rim surface to support enormous loads, allowing the vehicle to travel at high speeds without the tire exploding. It is resistant to abrasion, which is the process of reducing it to wire size with steel round bars. Through the cold-drawing process, a thin line becomes dense and brittle, gaining mass and tensile strength (Cisa Pushes Tax Changes to Boost China Steel Scrap Use 2021). The wire is not curved, cannot be briquettes, and cannot break, as depicted in the image. Thailand is the origin of these imports of raw materials. Majority of worn-out tires In Thailand, more than 30 million vehicles are registered, including 800,000 10-wheelers, 18-wheelers, and 8-wheeler buses. Each line of old truck tires weighs 40 kg, totalling over 300,000 tons per year. Nakhon Pathom Suphan, Korat, and Surat Rong Lim are locations where used tires can be purchased. The pyrolysis plant can produce fuel oil, while used tires can be burned directly. The purchase price ranges between fifty and three hundred Thai Baht. If you can still cast flowers, deduct between 500 and 700 baht per line. At this location, one can purchase a service.

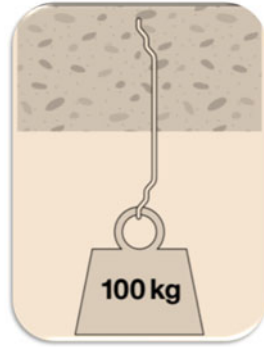
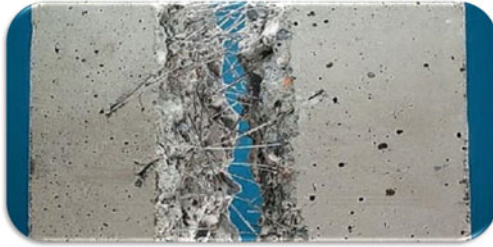
To replace the steel grating, bonding before pouring the floor, such as deformed wire mesh pre-cast that is not received as it is depicted in Fig. 6.2.

Advantages:

1. Pressure-bearing, bearing forces give concrete much more strength.
2. Controls cracking, increases tensile strength, and increases strength.
3. The anti-crack concrete cast floor will experience fatigue.
4. Increase impact resistance and durability.
5. Reduce concrete density and risk.
6. Reduce the quantity of excess iron. Avoid wasting time by adding iron.
7. Reduce construction duration by more than 70%.
8. Reduce labour costs for steel tying.
9. Place the supporting steel for the cement ball.
10. Can be poured on top of the existing floor.
11. Prevent penetration.
12. Seamless floor.
13. Transportable and packaged in sacks or crates.
14. If a wall lacks a solid window, the glass may cause signal loss.

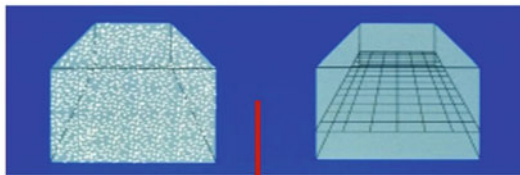
Appropriate for particular types of labour. Reduce costs by at least 30% based on the value of material investments and energy savings.

Old tires are omnipresent waste products that are rapidly increasing in quantity. Due to the rapid increase in the number of passenger cars and transport trucks, hydrocarbons, which are also used as fuel for the combustion system, are the primary component of tires. Production process the pyrolysis process (pyrolysis) is widely used because it converts tires into gas, solid, and liquid fuel (oil). The tire's composition is composed of 85% rubber, 12% reinforcing steel, and 3% fibre by weight. From a chemical standpoint, they are 51% hydrocarbons, 26% carbon black, 13% oil, 2% zinc oxide, and 1% sulfur from a chemical standpoint. The allure of the steel bar made of high-carbon steel that is encased in rubber is determined by its proximity to



**What is the purpose of concrete reinforcement?**

Because concrete is brittle, it tends to shrink slightly both during and after curing. At the surface, plastic shrinkage occurs. and volumetric changes cause internal internal stresses. Matrixconcrete Steel bars and welded wire mesh are used to increase the tensile strength of the internal structure. (plain reinforcement)



**Steel Fiber**

- Reinforcement in three dimensions
- Always correctly placed
- Reinforcing cracks from shrinkage
- Reduces bleeding and sedimentation
- Improves impact and abrasion resistance
- Provides resistance to cracking and slipping
- It reduces permeability
- Improved freeze/thaw resistance.
- It provides resistance to fragmentation and explosion.

**Rebar/Wire Mesh**

- Reinforcement in two dimensions
- Difficult to get the right position
- When cracks appear, they must be controlled.
- Introduced induction coupling at the center10m

**Fig. 6.2** Recycled fibre steel for reinforced concrete features and comparison with other existing products (RSFRC). *Source* Authors

the rubber. Copper or brass, which have high strength, may be used to coat the exterior. Excellent flexibility and fatigue resistance, as it is depicted in Fig. 6.4. Bringing steel bars to a blast furnace to melt It is not widely used because the rebar is small and thin, causing it to burn quickly in the furnace rather than rust the iron. Mixing it with cement is yet another method of application (Fig. 6.3). Polyester, nylon, polyamide, and rayon are the most common high-strength fibres used to reinforce the shape of tires.

## Benefits

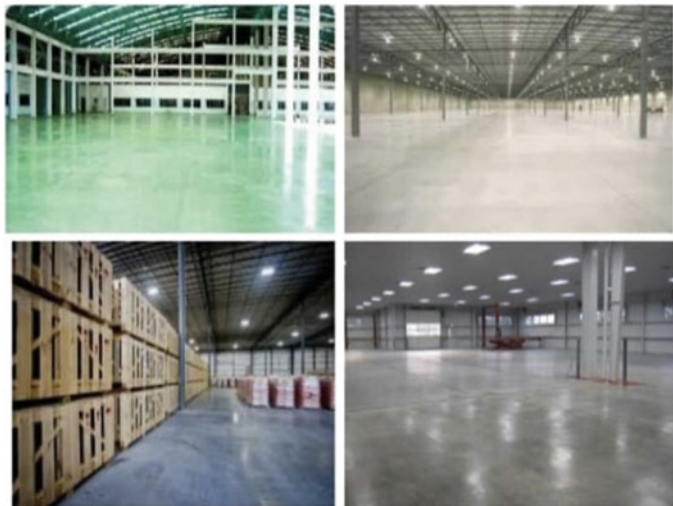
### To the contractor:

- Reduce labor costs.
- Reduce time on schedule.
- Unlike wire mesh, which takes hours, steel fibers can be installed in 5 minutes.
- The truck can be driven to the desired configuration. Without the need for a pump.
- Construction time reduced.
- Easy to use.
- Environmentally friendly packaging.
- Supports laser screed and vibrating screed.

### To the owner:

- Low construction cost.
- High quality.
- Eliminates concerns that the net is not properly positioned.
- Stop small cracks from spreading to larger cracks.
- Reinforced edges prevent joints from breaking.
- Provides high impact resistance.
- Able to achieve excellent surface finish.
- Eliminates slippage due to corroded reinforcement.

## Main Applications - Industrial Flooring



**Fig. 6.3** Recycled fibre steel for reinforced concrete benefits for the shareholders (RSFRC). *Source* Authors





Specifications	Steel Bar	Steel Fiber	Recycled Steel Fiber	Polypropylene Fiber
Picture				
Tensile Strength	420-1400 MPa	1000-2900 MPa	1000-2,500 MPa	50-600 MPa
Additional Rate Range	.....	1-3% of mass UHPC	1-3% of mass UHPC	1-3% of mass UHPC
Toughness/Elongation At Break	6-14%	more than 6%	more than 6%	more than 7%
Elastic Modulus	200 GPa	more than 30 GPa	more than 30 GPa	more than 6.6 GPa
Price	600\$- ... /ton	300\$ - ... /ton	...\$ - ... /ton	1000\$ - ... /ton
Standard	ISO/TC 17/SC 3 ISO/TC 17/SC 17 ISO/TC 82 ISO/TC 17/SC 4	ISO 13270:2013 ASTM C 1399 ASTM C 1581 ACI 544.1R	ASTM C 1399 ASTM C 1581 UNE EN 14845-1 UNE EN 12390-3 UNE EN 4651 ACI 544.1R	

Fig. 6.4 Compares the properties of steel fiber in the market. *Source* Authors

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