



MASCI
Mekong Area Sustainable Cities Initiative

Supported by
MLCSF 2023



LANCANG-MEKONG
COOPERATION
SPECIAL FUND

SUMMARY REPORT AND BEST PRACTICE GUIDEBOOK

Project Title: Circular Economy (CE) Capability Building in the Lancang-Mekong Region: Product Verification of Plastics Packaging in Supply Chains

Duration: 1 Year (December 2022 – November 2023)

Implementing Agency: Management System Certification Institute (Thailand) (MASCI), Ministry of Industry, Thailand

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Executive summary

The economic development of the Mekong Countries over numerous years has demonstrated a notable increase in consumption driven by swift population growth. The expanding economies and populations have led to a substantial rise in energy and material utilization, coupled with a significant surge in waste production. This has imposed considerable additional strain on the finite and precious natural resources, as well as the environment, of the Mekong Countries.

In the Mekong Countries, specifically Cambodia, the forecasted total waste generation under a 'business as usual' scenario is anticipated to increase from 33 million tonnes per annum (tpa) in 2017 to 99 million tpa by 2050. Vietnam holds the 7th position among the top global contributors to plastic waste, producing over 1.8 million tons per year. In Thailand, approximately 12% of the overall waste generated consists of plastic waste, with 2 million tons recycled at a rate of 0.5 million tons, while the remaining 1.5 million tons predominantly comprise single-use plastics (SUP).

A substantial portion of this waste is mishandled, eventually leaking into the environment through practices such as littering and stormwater washouts.

The Mekong River is singled out among a group of ten rivers responsible for discharging 95 percent of the plastics adversely affecting the world's oceans. Recognizing the gravity of the environmental pollution issue, the Mekong Countries acknowledge the formidable challenges posed to resource and waste management.

Most of the Mekong Countries have national strategy and action plans with some projects to transform to CE.

In 2021, Cambodia initiated the National Circular Economy Strategy and Action Plan, aiming to transition to a circular economy. The goals include enhancing sustainable production and energy use, promoting sustainable consumption, and reducing waste generation at the source.

Meanwhile, Lao PDR identified Circular Economy (CE) Strategies in 2017, focusing on priority areas such as circular manufacturing, textiles, and waste management.

Myanmar launched SWITCH-Asia Prevent Plastics in 2020, with the primary objective of promoting sustainable production and consumption patterns. The initiative involves raising awareness and implementing best practices in waste management. Specific goals include adopting sustainable management practices in four industrial zones, increasing the availability of eco-friendly packaging, and enhancing consumer awareness about plastic reduction and prevention.

Vietnam is actively transitioning from a linear economy to a circular one, emphasizing three pillars: designing and extending material lifespan, reducing waste and emissions, and restoring the ecological system. The country is eager to learn from others' experiences in building a circular economy.

In Thailand, the Circular Economic Model extends beyond waste management, aiming to create monetary and economic value through product and process modification. The government has approved a five-year strategic plan to boost the bio, circular, and green (BCG) economy, considering it the optimal path to sustainability, along with promoting more equitable and resilient development.

While all Mekong Countries acknowledge the necessity of addressing the plastic waste issue, the rationale for taking action varies. Several countries have initiated practices to deal with plastic waste problems. However, some are in the early stages of implementation, while others lack notable ongoing initiatives.

The challenge stems from **the absence of clear guidelines for Circular Economy (CE) implementation**, particularly regarding techniques for implementing CE products. This includes innovation and rethinking of common products to reduce waste, minimize natural resource usage, and incorporate processes such as upcycling and return to refill. Additionally, there's a need for means to verify these CE products in the supply chain.

There is also a noticeable gap in knowledge related to systemic and efficient guidelines for plastics waste management throughout the entire supply chain.

Given the current state of Circular Economy (CE) implementation in the six Lancang-Mekong Countries and the Lancang-Mekong Cooperation's dedication to advancing the UN 2030 Agenda for Sustainable Development, building capabilities in CE implementation is crucial.

This is especially true in the plastic supply chain, recognized as one of the most substantial and pressing factors. Enhancing these capabilities is of utmost importance for the Lancang-Mekong Countries, enabling them to propel economic, social, and environmental transformations essential for realizing a circular economy.

The objectives of the project are

1) Transfer knowledge on implementing Circular Economy (CE) product verification for plastics packaging in supply chains from successful countries, regions, or cooperatives to the Lancang-Mekong Region, aiming to enhance their capabilities in CE product verification for plastics packaging in supply chains.

2) Expedite the realization of Sustainable Development Goals (SDGs), particularly Goal 11: Sustainable cities and communities, Goal 12: Ensure sustainable consumption and production patterns, and Goal 13: Climate action within the Lancang-Mekong Region.

The benefits from this project can be explained as follows:

Circular Economy (CE) experts in Thailand, serving as the regional hub, will undergo training to become trainers in CE product verification implementation for plastics packaging in supply chains. This training will be conducted by experts from foreign countries, regions, or related organizations.

Participants from Lancang-Mekong Countries will gain knowledge of CE product verification implementation for plastics packaging in supply chains through participation in a training course led by Thai trainers, while others will learn from a published guideline handbook.

All Lancang-Mekong Countries will have the opportunity to expand the scope of CE product verification implementation for plastics packaging in supply chains across the region, aiming for the widest possible impact.

There are key output and activities are described as follows:

Report and guidelines handbook

Desk research report

The research report focuses on the verification of Circular Economy (CE) products, specifically in the context of plastics packaging within supply chains in various foreign countries, regions, or related cooperatives. This includes entities like Sweden, the European Union (EU), and the United Nations Development Programme.

Chapters 1-6 provide an overview covering: The global plastics industry and plastics packaging overview; The trading situation in the plastic industry and plastics packaging; Global usage patterns of plastics; Laws, regulations, and policies related to plastics packaging; The concept and implementation of Circular Economy (CE); Case studies on Eco design theory and practice; and Expert interviews on the Circular Economy (CE) of plastics products

Guideline handbook for CE product verification

The handbook providing guidelines for the implementation of Circular Economy (CE) product verification in plastics packaging within supply chains has been published for application by the Lancang-Mekong Region Countries

Chapters 7-14 encompass the following topics in the product verification guideline handbook:

CE product verification techniques; CE standards and certifications (e.g., ISCC Plus, ISO/IEC 17029, Cradle to Cradle Certification, EU Ecolabel); Implementing CE product verification in the supply chain; Identifying products suitable for verification; Selecting the appropriate verification techniques; Integrating verification into existing processes; Making use of the developed project standard; Monitoring and evaluation; Importance of monitoring and evaluating CE product verification implementation in the supply chain; Guidance on measuring and tracking progress; Case studies and examples of CE product verification; Examples of organizations successfully implementing CE product verification for plastics packaging in their supply chains; Case studies highlighting the benefits of CE product verification for plastics packaging; Best practices in circular economy product and waste management. Readers can easily follow the guidelines in Chapters 7-14 of the CE product verification handbook.

Chapter 15 showed Summary from CE product verification guideline handbook. The guideline handbook for Circular Economy (CE) product verification in Lancang-Mekong Region Countries has been developed as a resource to assist organizations in integrating

sustainable practices into their supply chains. Offering extensive guidance, the handbook covers the requisites of CE product verification, incorporating pertinent standards and certifications, monitoring and evaluation processes, and illustrated success stories of implementation. It emphasizes the critical role of monitoring and evaluating CE product verification in supply chains, providing instructions on gauging progress and making necessary adjustments.

The handbook features case studies and examples that showcase how organizations have effectively implemented CE product verification, highlighting both the advantages and challenges inherent in the process. A key insight gleaned from these examples underscores the significance of selecting the appropriate standard or certification tailored to the business and its products. Each standard and certification comes with its unique set of criteria, necessitating alignment with the company's goals and values.

Furthermore, the handbook underscores the pivotal role of monitoring and evaluating the implementation process to ensure the attainment of intended goals and facilitate adjustments as needed. It provides guidance on measuring and tracking progress, advocating for the establishment of measurable goals and regular progress assessments to pinpoint areas necessitating improvement. This iterative process allows businesses to continuously enhance their sustainability practices, meeting their commitments while concurrently improving their bottom line.

In essence, the guideline handbook for CE product verification in Lancang-Mekong Region Countries serves as a comprehensive guide for businesses seeking to integrate sustainable practices into their supply chains. By adhering to the outlined guidelines, businesses can mitigate their environmental impact, champion sustainability, and enhance their overall economic performance.

Training programs

Train the trainer

The training program for trainers focuses on implementing Circular Economy (CE) product verification, specifically targeting plastics packaging in supply chains. The course spans five days, with two instructors being experts from foreign countries, regions, or related organizations. Fifteen participants, all experts from Thailand, will engage in the training.

Training course on CE product verification implementation for plastics

The training program for Circular Economy (CE) product verification implementation, specifically addressing plastics packaging in supply chains, is designed for Lancang-Mekong Countries. The course spans five days, with five instructors being experts from Thailand who have completed the train-the-trainer course. The participants consist of 60 staff members from industrial sector enterprises, government entities, or related organizations in the Lancang-Mekong Region Countries.

MASCI hosted the "Circular Economy (CE) Implementation Training: Product Verification for Plastic Packaging in Supply Chains" at The Berkeley Hotel Pratunam from August 7 to 11, 2023. The primary objective of the training was to share knowledge on CE product verification, drawing insights from successful cases across various countries, regions, and international organizations. The target audience included participants from Mekong Region countries, namely Cambodia, Laos, Myanmar, Vietnam, and Thailand, with a total of 60 attendees representing government agencies, the private sector, and educational institutions.

Dr. Chavatip Chindavijak, currently serving as the Senior Vice President at the Management System Certification Institute (MASCI) was the main trainer for this training course. Dr. Chindavijak specializes in futuristic and strategic thinking, organizational change, and sustainability and resiliency at the organizational level. With a robust and diverse background, he has worked extensively with multinational companies, SMEs, and government agencies, providing training and coaching services to senior executives, particularly in raising awareness of Sustainable Development Goals (SDGs).

Dr. Chindavijak actively supports industries in transforming their management approaches to align with SDGs, employing international standards and frameworks to optimize outcomes for the environment, society, value chain, and organizational levels. Additionally, he holds a position in the Sub-technical Standard Committee of Circular Economy at the Thai Industrial Standards Institute (TISI).

As the project manager, Dr. Chindavijak will assign tasks and responsibilities to team members, oversee adherence to the project timeline, and ensure the achievement of project objectives, culminating in the submission of a comprehensive completion report. Each team member will directly report the results of their respective activities to the project manager.

The summary of the training materials can be found in **Chapter 16**. Chapter 16 described Overview of Chain of Custody: Principles and Concepts, Verification Process and Methodology, Workshop on Verification Scheme: Developing Verification Scheme for CE Product, and Practical Exercise on Integrating Knowledge to Develop CE Product Verification Based on Country Context. The workshop concentrates on formulating a robust CE product verification standard tailored to the plastic supply chain, with a specific emphasis on sectors engaged in recycling plastic bottles, recycling plastic bags, recycling food storage containers, and manufacturing plastic products from recycled materials. Participants actively participate in collaborative exercises outlined in the workshop.

Chapter 17 showed the feedback from participants which includes 1) the pre-test results from CE Implementation prior Training -Product Verification for Plastic Packaging in Supply Chains Training Evaluation and 2) summary results of open-ended questions.

Most of the participants in the program represent government agencies, such as the Ministry of Industry, Science, Technology and Innovation, Heads of the agriculture department and Agriculture Department etc. Additionally, there are participants from the private sector, specifically a consulting firm that offers advisory services for developing Circular Economy (CE) policies for clients. An initial pre-test survey was conducted to measure participants' knowledge across ten different aspects. The findings revealed that participants rated themselves below average (answering 2) on the following topics: Circular Economy Principles and Concepts; Process Verification Scheme Related to CE Product; Chain of Custody Principles and Concepts; Conformity Assessment; Developing Verification Scheme for CE product; Requirement Setting for process or product traceability; Requirements and implementation for related social issues; Knowledge and Experience Sharing from SCGC in process verification.

On the other hand, participants rated themselves an average of 1 in the areas of BCG Policy and Initiatives in Thailand (indicating a weaker understanding).

Participants rated themselves an average of 3 (average understanding) about the Global trends and challenges in the Plastic Industry.

Following the post-test of the training, participants demonstrated a significant level of understanding on CE product verification. They highlighted the trainer, exercises, and best

Chapter 1 Global Plastics Industry and Plastics Packaging Overview

1.1 Global Plastics Resin Situation

During 2017–2021, the world's import-export value of plastic resins has grown at an average rate of +7.03% and +9.43% per year. However, there has been a slowdown in the plastic processing and manufacturing industries during the COVID-19 virus pandemic. In 2021, the recovery of the trade and plastic processing and manufacturing industries was observed from the value of global import-export of plastic resins that had expanded from 2020. Still, in 2022 the import-export value was at 364,361 million USD and 370,800 million USD, respectively. Compared to the same period in 2021, the import-export value has contracted and decreased by -0.27% YoY and -1.54% YoY, respectively (Figure 1a).

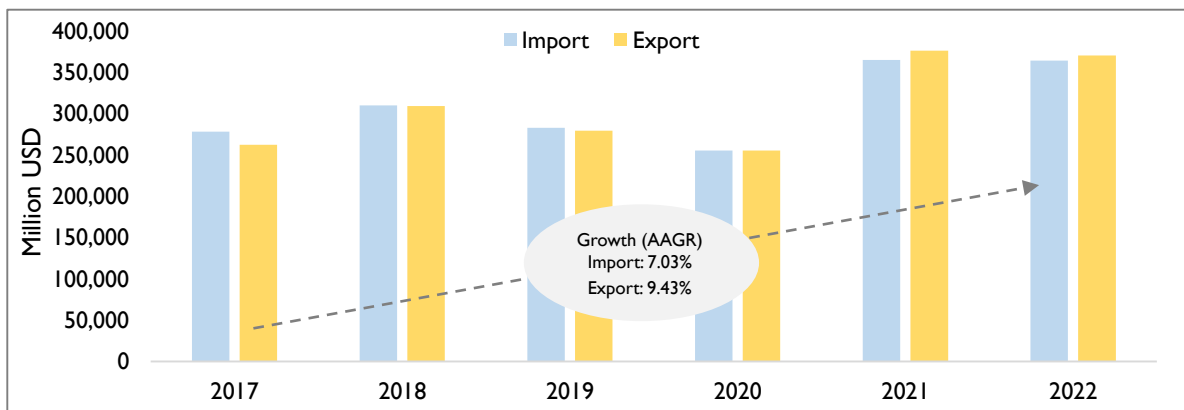


Figure 1a Global Plastic Resin Import-Export Value 2017-2022

source: Plastics Institute of Thailand (n.d.)

In 2022, China has the highest plastic resin imports in the world. China produces over 100 million tons of plastic raw materials annually and consumes over 30 million tons of plastic products, with the proportion of imports accounting for approximately 15%. The second and third highest proportions of plastic resin imports are Germany and the United States, which account for 7% of the world's total plastic resin imports. The value of plastic resin imports from both countries has grown by +4.3% and +10.2% YoY, respectively. As for plastic resin exports, the country with the highest proportion of global plastic resin exports is the United States, followed by Germany, and France, respectively. The value of plastic resin exports from the United States has decreased by -1.73% YoY, while those from Germany and France have increased by +1.41% and -1.81% YoY, respectively.

1.2 Global Plastics Product Situation

In the past, from 2017 to 2021, the global plastic product trade, both import and export, has shown a continuous growth trend with an average annual growth rate of +7.08% and +8.32%, respectively despite the Covid-19 virus pandemic as there was increased demand for plastic components in the medical equipment sector during that period. Additionally, the expansion of online ordering and food delivery businesses as part of the new normal consumer behavior has contributed to the increased consumption of plastic products. In 2022, the global value of plastic product imports and exports was recorded at 348,233 million US dollars and 398,353 million US dollars, respectively (Figure 1b).

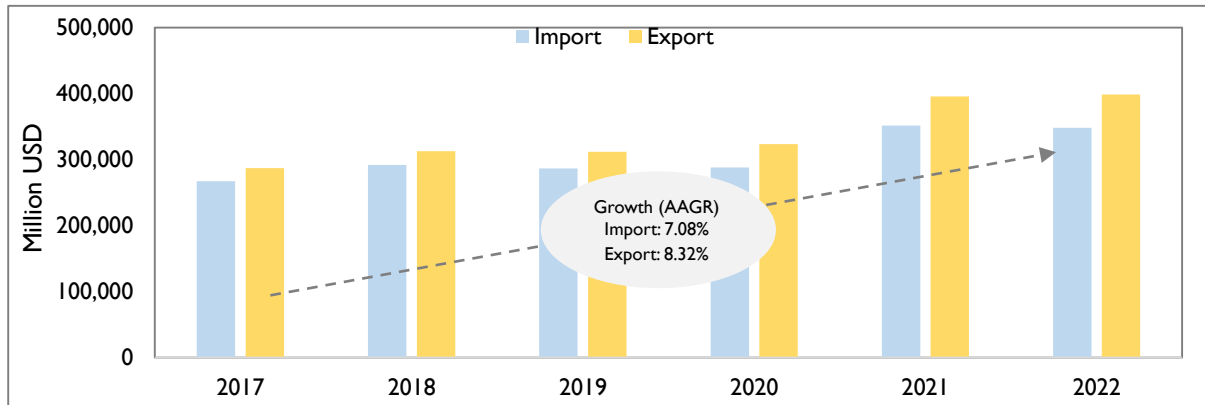


Figure 1b Global Plastics Product Import-Export Value 2017-2022

Source: Plastics Institute of Thailand (n.d.)

In 2022, the United States remained the country with the highest value of imported plastic products as it is the largest consumer goods market in the world. The value of US plastic product imports accounted for 17% of the world's total plastic product imports, or a value of \$58,347 million USD with +6.7% YoY increase. The second-ranked country is Germany, which accounts for 8% of the world's total plastic product imports, or a value of \$26,982 million USD. The countries with the highest proportion of plastic product imports in the 3rd to 5th ranks are China, France, and Mexico, respectively which accounts for 5% of the world's total plastic product imports. For imported plastic products, China is the country with the highest value of plastic product exports in the world, with a value of approximately 107,589 million US dollars or 27% of the total value of plastic product exports in the world. Germany which accounts for 11% of the total value of plastic product exports in the world is at number two followed by the United States (9%), Italy (4%), and Poland (4%), respectively.

1.3 Thailand Plastics Product Situation

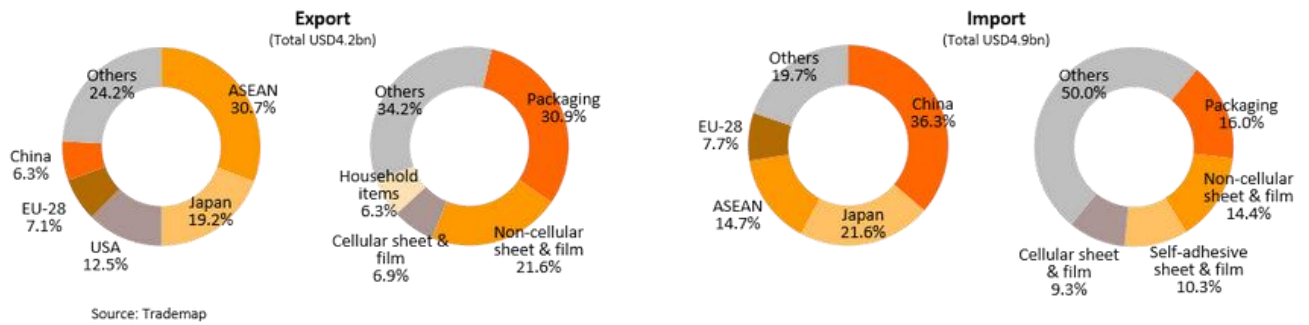
Thailand domestic sales and export volume of plastic products are projected to rise by an average of 2.0-3.0% per year over 2021-2023 with the anticipated recovery in the Thai and global economies, especially downstream industries, including packaging, electrical appliances, construction, auto parts, and medical devices which collectively account for almost 80% of domestic consumption of plastic products. The lingering challenges for the industry over the next 3 years include uncertainty over the direction of crude oil prices (input in the production of plastic resins), rising labor costs, and concerns over the environmental impacts of plastics at

home and abroad that are discouraging the consumption of single-use plastic items. In 2019, the plastics industry accounted for 6.1% of Thai GDP, playing an important role in linking between the petrochemicals sector which supplies upstream inputs, with end-user industries (especially packaging, construction, auto assembly, electronics and electrical appliances, and medical equipment), and for which the plastics industry provides finished and semi-finished products.

Manufacturing plastic products involves melting and molding plastic resins, cooling the molded plastic, and final processing to produce the desired finished goods. Dyes and plasticizers may be added to change the color and characteristics of the goods and to make them more suitable for their intended use. There are several methods to mold plastics e.g., blow molding, injection molding, compression molding, and extrusion molding. A survey by the Plastics Institute of Thailand in 2019 reveals 35-40% of Thai plastics producers use injection molding, followed films and blow molding.

Thailand occupies an important place in the global plastics industry. The domestic industry generates around THB 1.0 trillion annually. The industry benefits from a domestic petrochemicals industry that is both sizeable and highly-efficient compared to its competitors in the ASEAN zone. And because plastic resins sit downstream from the petrochemicals industry, this helps to increase the competitiveness of Thai manufacturers. By producing a wide range of resins (in both quality and price), Thai companies support the activities of a large number of different industries. In 2019, Thai manufacturers produced 9.0 million tonnes of plastics, while the country imported just 2.2 million tonnes. The 56% of output is for export markets. Thailand is the world's 11th biggest exporter of plastics and the 2nd biggest in the ASEAN zone after Singapore. The remaining 44% is for domestic industries, most notably for players in auto assembly, electronics and electrical appliances, and construction. Thai plastics converters are embedded in comprehensive supply chains that stretch from upstream raw materials (i.e., domestic producers of natural gas products), through intermediate goods (i.e., petrochemical players manufacturing plastic resins), to a large number of downstream industries (Aphinya Khanunthong Krungsri Research, 2022). There are currently more than 2,800 plastics converters active in Thailand, comprising 87% SMEs and 13% large players. The large number of SMEs is because of low entry barriers to the market given relatively small up-front investment costs, low to mid-level technology for commodity-grade production. As a result, competition is fairly stiff and margins are narrow with most players from Thai companies (83.5%), Japanese (7.5%), and then Chinese (1.2%). In terms of geographical distribution, the majority of operations (81.5%) are clustered in the central region, especially in the Bangkok Metropolitan Region, Samut Prakan and Samut Sakhon, followed by the east (11.4%) and the northeast (3.1%).

The domestic market consumes 80% of the output of Thai plastics converters, which is split into two primary segments: (i) end-consumer market and (ii) suppliers to the end-user industries. The latter comprises five major markets – packaging, electronics & electrical appliances, construction, auto parts, and medical devices & supplies. The remaining 20% is exported. Most of the export are low-value commodity-grade products including packaging and cellular and non-cellular films. The main export markets in 2019 were the ASEAN zone (30.7% of all exports by value), Japan (19.2%) and the US (12.5%). The imports in 2019 include plastic packaging (16% of all imports), non-cellular films (14.4%) and self-adhesive films (10.3%) mainly from China (36.3% of all imports by value), Japan (21.6%) and the ASEAN region (14.7%) (Figure 1c)



Source: Trademap

Figure 1c Trade Share of Plastic Products Values in 2019 (HS 3916-3926)
Source: Aphinya Khanunthong Krungsri Research (2022)

In plastics products production, raw materials (i.e., plastic resins) generally account for around 70% of production costs, with another 12% coming from labor, 8% from energy and 10% attributable to other costs. In plastic packaging, (most important product category) the primary expense is for resins (50-80% of production costs). Total energy and labor costs are 5-11% and 3-11% respectively depending on the type of inputs used and the products manufactured. The depreciation and interest costs are 0-20% and 11-15% for other costs. The fluctuating crude oil and natural gas prices can have substantial influence on manufacturers' costs and competitiveness.

Chapter 2 Plastic Industry and Plastics Packaging Trading Situation

2.1 Global Trading Situation

In the past, from 2017 to 2021, the global trade value of plastic packaging for both imports and exports has shown a continuous growth trend, with an average annual growth rate of +6.14% and +7.28% respectively. Despite the COVID-19 pandemic, the overall trade of plastic packaging was relatively less affected compared to products in other groups as the plastic packaging is a product that is closely related to consumers' daily lives. During the COVID-19 pandemic outbreak, plastic packaging and disposable plastic products have become products with increasing usage due to consumers' concerns about health and hygiene, and the growth of e-commerce businesses. In 2021, as the severity of the COVID-19 pandemic situation decreased, there is a significant increase in the import-export value of plastic packaging (Figure 2a). For global plastic packaging imports and exports in 2022, it was found that the values were \$159,796 million and \$178,992 million, respectively. The growth trend of the plastic packaging trade is expected to continue.

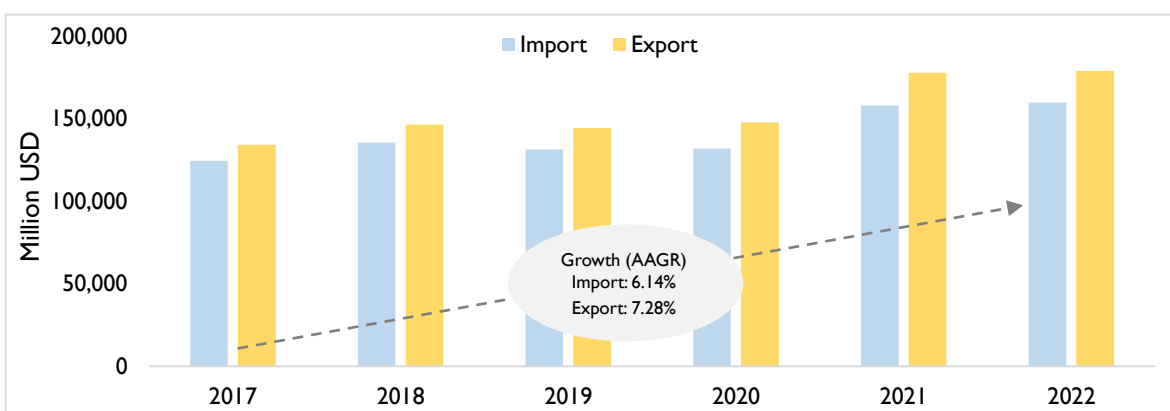


Figure 2a Global Plastic Packaging Imports and Exports Value from 2017 to 2022

Source: Plastics Institute of Thailand (n.d.)

Asia

China's Plastics Industry, Plastic Resin Trade Situation, and Plastic Products Trade Situation

The overview of China's plastic trade shows that the value of China's plastic imports has increased significantly, especially during the period of 2017–2021, with an average annual growth rate of 4.25% (Figure 2b). In 2021, China's total plastic imports were approximately 61,149 million US dollars. Meanwhile, the overall value of China's plastic exports has also increased, from 15,031.44 million US dollars in 2017 to 29,830.67 million US dollars in 2021, with an average annual growth rate of 18.69%. For 2022, China's plastic exports were valued at 36,505.11 million

US dollars, which represents a 22.37% YoY increase from the previous year, while plastic imports were valued at 56,170.87 million US dollars, representing an 8.14% YoY decrease from the previous year.

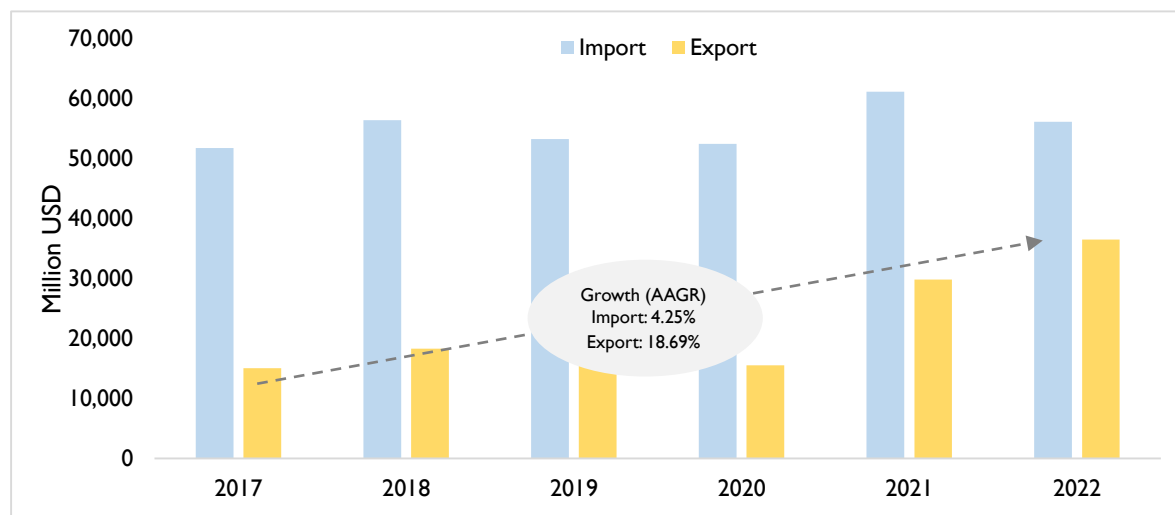


Figure 2b China import-export plastic resin value in 2017-2022
Source: Plastics Institute of Thailand (n.d.)

In 2022, India was the main trading partner for China's plastic resin exports, with a market value proportion of 8.44% compared to the overall export value, followed by Vietnam, South Korea, Russia, and the United States, respectively. For China's plastic product imports in 2022, South Korea was the main trading partner in the import sector with a market value proportion of 18.02%, followed by Taiwan, the United States, Japan, and Saudi Arabia, respectively.

As for the plastic products trade in China, the value of plastic product imports has increased significantly, particularly during the period from 2017 to 2021, with an average annual growth rate of 5.98%. China's total value of plastic product imports was approximately USD 21.69 billion, an increase of about USD 3.03 billion from the previous year (Figure 2c). The value of plastic product exports from China has also increased significantly, from USD 56.28 billion in 2017 to USD 101.43 billion in 2021, with an average annual growth rate of 15.87%. In 2022, the plastic product exports and imports for China were USD 107.59 billion (a 6.07% YoY increase from the previous year) and USD 19.06 billion (a 12.14% YoY decrease from the previous year) respectively.

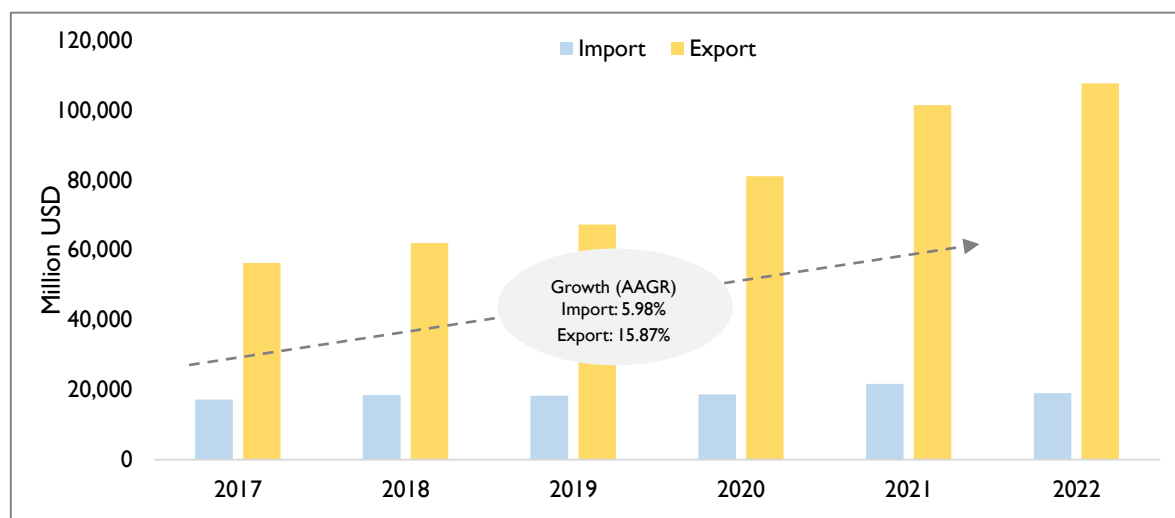


Figure 2c China Import-export value of plastic products in 2017–2022

Source: Plastics Institute of Thailand (n.d.)

The United States was the top trading partner for China's major export markets in 2022, accounting for 23.75% of the total export value, followed by Japan, Vietnam, Australia, and Malaysia. For China's plastic product imports in 2022, the top trading partner was Japan, accounting for 29.86% of the total import value, followed by South Korea, the United States, Taiwan, and Germany, respectively.

China exported the most plastic products in the packaging industry group, accounting for 33.83% of the total value of plastic product exports. The next highest groups were construction material components, household appliance components, automotive parts, and medical equipment components, respectively. In 2022, the export in packaging industry group accounted for 33.16% of the total value, followed construction material components, household appliance components, automotive parts, and medical equipment components, respectively. In 2022, China imported the most plastic products in the packaging group, accounting for 37.13% of the total value of plastic product imports in China, followed by the automotive parts industry group, construction material components industry group, electrical and electronic equipment components industry group, and household appliance components industry group, respectively.

Japan's Plastics Industry, Plastic Resin Trade Situation, and Plastic Products Trade Situation

For Japan's plastic trade, the value of Japan's plastic imports has increased significantly, especially during the period of 2017-2021, with an average annual growth rate of 3.52%. In 2021, Japan's total plastic imports were approximately 6.898 billion US dollars. In the export sector, Japan's total plastic exports increased from 12.017.05 billion US dollars in 2017 to 14.124.44 billion US dollars in 2021, or an average annual growth rate of 4.12%. In 2022, the plastic export and import values for Japan are 13.164.83 billion US dollars and 7.663.84 billion US dollars, respectively.

In 2022, the main trading partner for Japan's plastic pellets in the export sector was China, with a market value share of 32.18%, followed by the United States, India, Taiwan, and South

Korea, respectively. In the import sector, the main trading partners for Japan were the United States, with a market value share of 16.38%, followed by Taiwan, China, South Korea, and Thailand, respectively.

For Japan's plastic product trade, the value of Japan's plastic product imports has increased significantly, especially during the period of 2017-2021, with an average growth rate of 3.65% per year. In 2021, Japan's total value of plastic product imports was approximately 10,447.75 million US dollars. In the export sector, the total value of Japan's plastic product exports increased from 13,135.39 million US dollars in 2017 to 16,198.24 million US dollars in 2021, with an average growth rate of 5.38% per year during the period of 2017-2021. In 2022, the imports and exports values of Japan's plastic product exports were 10,553.81 million US dollars and 13,860.63 million US dollars, respectively.

In 2022, the main trading partner for Japan's plastic products in the export sector was China, accounting for 36.08% of the market value compared to the overall export value, followed by South Korea, Taiwan, the United States, and Vietnam, respectively. Meanwhile, the main trading partners for Japan in the import sector in 2022, were China (44.47% of the import value), followed by Vietnam, the United States, Thailand, and South Korea, respectively.

Japan exported the most plastic products in the packaging industry group, followed by the automotive parts industry group, the electrical and electronic components industry group, the construction materials industry group, and the household appliance industry group. In 2017, the packaging industry group accounting for 36.76% of the total value of plastic product exports from Japan. In 2022, the packaging industry group accounted for 36.72%. In 2017, Japan imported the most plastic products in the plastic packaging group, accounting for 45.62% of the total value of plastic product imports followed by construction material component group, industrial automotive component group, household appliance group, and electric and electronic appliance component group, respectively. In 2022, the packaging industry group accounted for 44.26% of the total value of plastic product imports.

South Korea's Plastics Industry, Plastic Resin Trade Situation, and Plastic Products Trade Situation

In South Korea's Plastic Trade, the value of plastic imports of South Korea has increased significantly, especially during the period of 2017-2021, with an average growth rate of 4.47% per year. In 2021, South Korea's total plastic imports were approximately \$6,088.68 million. In the export sector, South Korea's total plastic exports have increased from \$21,288.31 million in 2017 to \$30,520.32 million in 2021, with an average growth rate of 9.42% per year during the period of 2017-2021. In 2022, the total value of South Korea's plastic exports and imports were \$29,263.64 million and \$6,111.21 million, respectively.

The main trading partner for South Korea's plastic pellets in the export sector in 2022 was China, with a market value proportion of 32.16%, followed by Vietnam, the United States, India, and Turkey, respectively. As for the import sector, the main trading partners for South Korea were China with a market value proportion of 35.10%, followed by the United States, Japan, Germany, and Sweden, respectively.

The value of plastic product imports to South Korea has increased significantly, especially during the period of 2017-2021, with an average annual growth rate of 7.78%. In 2021, the country imported plastic products worth approximately 8,087.27 million US dollars. Meanwhile, in the export sector, the overall value of plastic product exports from South Korea was 12,673.76 million

US dollars. The value of plastic product exports from South Korea in 2022 was 11,894.44 million US dollars whereas the value of plastic product imports to South Korea was 7,703.88 million US dollars.

In 2022, the main trading partner for South Korean plastic products in the export sector was China, accounting for 25.47% of the market value, followed by the United States, Vietnam, Japan, and Taiwan, respectively. The main trading partner for South Korean plastic products in the import sector in 2022 was China, accounting for 36.51% of the market value, followed by Japan, the United States, Vietnam, and Taiwan, respectively.

South Korea exported the highest proportion of plastic packaging products in 2017, accounting for 41.00% of the total value, followed by the group of construction material components, the group of electronic and electrical appliance components, the group of automotive components, and the group of household appliance components, respectively. In 2022, plastic packaging products accounted for 40.53%. For import sector, South Korea imported the most plastic products in the packaging group, accounting for 42.83% of the total value of plastic product imports in 2017, followed by the automotive parts group, construction material group, electrical and electronic parts group, and household appliance group, respectively. In 2022, the packaging group imports accounted for 43.05% of the total.

CLMVT Countries

Cambodia’s Plastics Industry, resin trading situation, and plastic product trading situation

For plastic trade in Cambodia, the value of plastic imports has increased significantly, especially during the period of 2017-2021, with an average annual growth rate of 31.66% (Figure 2d). In 2021, Cambodia imported plastic resins worth approximately 358 million US dollars. In the export sector, the overall value of plastic resin exports from Cambodia during the period of 2017-2021 was 7.43 million US dollars. The value of plastic resin exports and imports in Cambodia in 2022 were 10.33 million US dollars and 335.34 million US dollars, respectively.

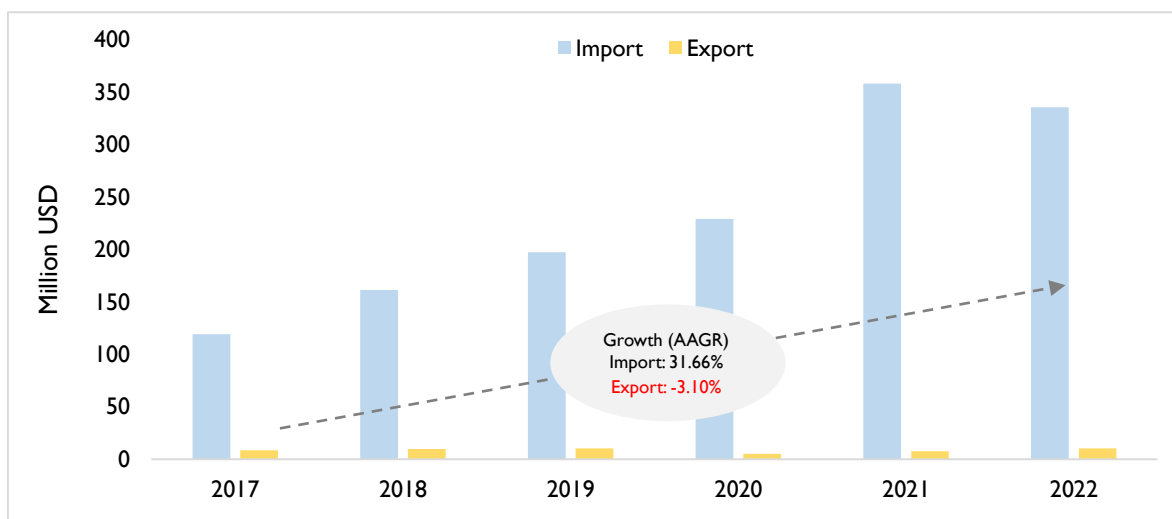


Figure 2d Plastic resin import-export value of Cambodia 2017-2022

Source: Plastics Institute of Thailand (n.d.)

The main trading partner for Cambodia's plastic resins in the export sector in 2022 was China, with a market value proportion of 60.08% compared to the total export value, followed by Malaysia, Taiwan, Colombia, and Singapore, respectively. In the import sector, the main trading partner for Cambodia was Thailand, with a market value proportion of 31.36%, followed by China, Singapore, Taiwan, and Malaysia, respectively in 2022.

For Cambodia's plastic product trade as shown in Figure 2-e, there has been a significant increase in the value of plastic product imports, particularly during the period of 2017-2021, with an average annual growth rate of 24.52%. In 2021, the total value of plastic product imports in Cambodia was approximately 767.13 million US dollars. The overall value of plastic product exports in Cambodia also increased significantly from 142.93 million US dollars in 2017 to 522.56 million US dollars in 2021. In 2022, the imports and exports of plastic product were 956.52 million US dollars and 551.57 million US dollars, respectively.

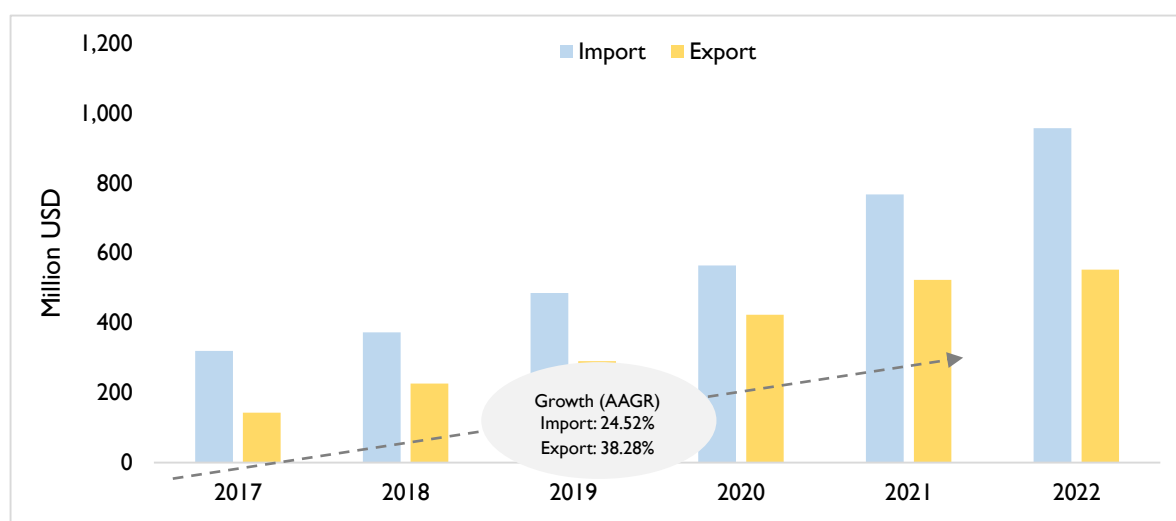


Figure 2e Plastic Product import-export value of Cambodia 2017-2022

Source: Plastics Institute of Thailand (n.d.)

In 2022, the main trading partner for Cambodia's plastic products in the export sector was the United States, accounting for 88.89% of the market value, followed by Canada, the UK, Spain, and China. The main trading partner for Cambodia's import was China, accounting for 76.92% of the import value, followed by Thailand, Hong Kong, South Korea, and Taiwan.

Cambodia exported the most plastic products in the construction materials group, accounting for 52.53% of the total value of plastic product exports, followed by plastic packaging group, household appliances group, automotive components group, and toys and fashion accessories group, respectively. In 2022, the construction materials group, accounted for 61.33%. Cambodia imported the most plastic products in the plastic packaging group in 2017, accounting for 43.36% of the total value, followed by the construction materials group, automotive components group, household appliances group, and electrical and electronic appliances group,

respectively. In 2022, the plastic packaging group accounted for 40.04% of the total value of plastic product imports to Cambodia.

Laos's Plastics Industry, resin trading situation, and plastic product trading situation

Overview of plastic trade in Laos reveals that in the import sector, the value of plastic pellets imported by Laos has increased significantly, especially during the period of 2017-2021, with an average growth rate of 11.55% per year. In 2021, the total value of plastic pellet imports in Laos was around 58.42 million US dollars, an increase of approximately 9.01 million US dollars from the previous year. On the other hand, in the export sector, the overall value of plastic pellet exports in Laos has also increased significantly during the period of 2017-2021, from 1.37 million US dollars in 2017 to 58.42 million US dollars in 2021, with an average growth rate of 105.99% per year.

For the value of plastic pellet exports in Laos in 2022, it was found to be 18.93 million US dollars, with a YoY decrease of 23.21% from the previous year. Meanwhile, in the import sector, the value of plastic pellets imported by Laos in 2022 was found to be 71.35 million US dollars, with a YoY increase of 22.14% from the previous year. The main trading partner for Laos' plastic pellets in the export sector was China, accounting for 67.94 percent of the market value, followed by Spain, Italy, Canada, and Thailand, respectively. Meanwhile, in the import sector in 2022, the main trading partners for Laos were Thailand, accounting for 76.66 percent of the import value, followed by China, the United States, South Korea, and Japan, respectively.

The value of plastic product imports into Laos has increased significantly, especially during the period of 2017-2021, with an average annual growth rate of 10.04%. In 2021, Laos had a total import value of plastic products of approximately 162.72 million US dollars. In the export sector, the overall value of plastic product exports from Laos was 3.46 million US dollars in 2021, with an average annual growth rate of -1.35%. In 2022, the value of plastic product imports and exports for Laos were 207.78 million US dollars and 4.78 million US dollars, respectively. The main trading partner for Laos' plastic products in the export sector was Thailand, with a market value proportion of 82.96%, followed by China, the Dominican Republic, Taiwan, and New Zealand, respectively. In the import sector in 2022, the main trading partner for Laos was Thailand, with a market value proportion of 61.40%, followed by China, Japan, Hong Kong, and Malaysia, respectively.

The largest proportion of plastic product exports from Laos in 2017 was in the plastic packaging group, accounting for 76.78% of the total value of plastic product exports from Laos, followed by the construction materials group, automotive parts group, household appliances group, and toys and fashion accessories group, respectively. In 2022, the plastic packaging group accounted for 58.10%. Laos imported the most plastic products in the packaging group, accounting for 45.36% of the total value of plastic product imports, followed construction material components, automotive industry components, household appliance components, and electronic and electrical appliance components, respectively. In 2022, the packaging group accounted for 48.54% of the total value of plastic product imports.

Myanmar's Plastics Industry, resin trading situation, and plastic product trading situation

The value of plastic imports in Myanmar has increased significantly, especially during the period of 2017-2021, with an average annual growth rate of 6.05%. In 2021, Myanmar imported plastic pellets with a total value of approximately 421 million US dollars. In the export sector, Myanmar's overall value of plastic pellet exports has increased to 12.00 million US dollars in 2021, with an average annual growth rate of 39.57%. The value of plastic pellet imports and exports in Myanmar in 2022 were 520.74 million US dollars and 17.43 million US dollars, respectively.

The main trading partner for Myanmar's plastic pellets in the export sector was China, with a market value share of 56.05% compared to the overall export value, followed by Malaysia, Germany, Indonesia, and the United Kingdom, respectively. Meanwhile, in the import sector in 2022, the main trading partners for Myanmar were Thailand, with an import value share of 41.79%, followed by China, Malaysia, Singapore, and Taiwan, respectively.

The value of plastic product imports has increased significantly, particularly in the period of 2017-2021, with an average annual growth rate of 4.98%. In 2021, Myanmar had a total plastic product import value of approximately 528.42 million US dollars. In the export sector, overall plastic product exports from Myanmar increased significantly to 93.01 million US dollars in 2021, or an average annual growth rate of 23.11%. In 2022, the value of plastic product imports and exports in Myanmar were 686.15 million US dollars and 81.72 million US dollars, respectively. The main trading partner for Myanmar's plastic products in the export sector was the United States, with a market value proportion of 36.43% compared to the overall export value, followed by Spain, Japan, China, and South Korea respectively whereas for import, the main trading partners for Myanmar were China with a proportion of 76.80% of import value, followed by Thailand, South Korea, Malaysia, and Hong Kong respectively.

In 2017, Myanmar had the highest proportion of plastic packaging exports, accounting for 44.47% of the total value of plastic product exports from Myanmar, followed by the construction materials group, automotive parts group, household appliance group, and electronics and electrical parts group. In 2022, ratio of plastic packaging increased to 57.08%. The highest imports of plastic products was packaging, accounting for 33.96% of the total value of plastic product imports, followed by the construction materials group, automotive parts group, electrical and electronic parts group, and household appliance group, respectively. In 2022, the ratio increased 38.76%.

Vietnam's Plastics Industry, resin trading situation, and plastic product trading situation

The value of plastic imports by Vietnam has increased significantly, especially during the period of 2017-2021, with an average growth rate of 14.43% per year. In 2021, Vietnam's total plastic imports were approximately USD 11.689 billion. In the export sector, Vietnam's overall plastic exports increased to USD 2.118 billion in 2021, with an average growth rate of 35.23% per year during the period of 2017-2021. In 2022, the value of plastic imports and exports in Vietnam were USD 12.064 billion and USD 2.301 billion, respectively.

The main trading partner for Vietnam's plastic pellets in the export sector in 2022 was Indonesia, with a market value proportion of 18.67%, followed by China, the United States, India,

and Japan. In the import sector, the main trading partner for Vietnam's imports was China, with a market value proportion of 22.14%, followed by South Korea, Taiwan, Singapore, and Thailand.

The value of plastic product imports to Vietnam has increased significantly, especially during the period from 2017-2021, with an average annual growth rate of 15.19%. In 2021, the total value of plastic product imports to Vietnam was approximately 8,045.22 million US dollars. The total value of plastic product exports from Vietnam has also increased significantly to 6,180.70 million US dollars in 2021, with an average annual growth rate of 17.64%. The main trading partner for Vietnam's plastic products in the export sector in 2022 was the United States, with a market value proportion of 37.98% compared to the total export value, followed by Japan, South Korea, Germany, and India. In the import sector, the main trading partners for Vietnam's imports were China, with a market value proportion of 58.72%, followed by South Korea, Japan, Taiwan, and Thailand.

Vietnam had the highest proportion of plastic packaging product exports in 2017, accounting for 53.11% of the total value of plastic product exports, followed by the construction material component group, household appliance group, automotive parts group, and electrical and electronic components group, respectively. In 2022, the plastic packaging product group were still the highest, accounting for 41.74% of the total value of plastic product exports. Vietnam imported the most plastic products in the packaging group, accounting for 37.61% of the total value of plastic product imports, followed by the construction material component group, electrical and electronic component group, automotive component group, and household appliance group. The ratios in 2022 was 37.44%.

Thailand's Plastics Industry, resin trading situation, and plastic product trading situation

The value of Thailand's plastic pellet imports has increased significantly, particularly in the period from 2017 to 2021, with an average growth rate of 6.05% per year. In 2021, Thailand's overall value of plastic pellet imports was approximately 5,376.89 million US dollars. In the export sector, Thailand's overall value of plastic pellet exports has also increased significantly to 11,059.08 million US dollars in 2021, or an average growth rate of 6.36% per year. The value of Thailand's plastic pellet imports and exports in 2022 were 5,561.07 million US dollars and 10,564.04 million US dollars, respectively.

The main trading partner for Thailand's plastic pellets in the export sector in 2022 was China, with a market value proportion of 29.36% compared to the overall export value, followed by India, Indonesia, Vietnam, and Japan, respectively. Meanwhile, in the import sector, the main trading partners for Thailand were China with a market value proportion of 22.80%, followed by Japan, South Korea, the United States, and Malaysia, respectively.

The value of plastic product imports to Thailand has increased, particularly during the period of 2017-2021, with an average annual growth rate of 4.88%. In 2021, the total value of plastic product imports to Thailand was approximately 5,374.50 million US dollars. The overall value of plastic product exports from Thailand has also increased to 4,410.60 million US dollars in 2021, with an average annual growth rate of 2.90%. In 2022, the value of plastic product imports and exports from Thailand was 5,365.12 million US dollars and 4,545 million US dollars, respectively (Figure 2f).

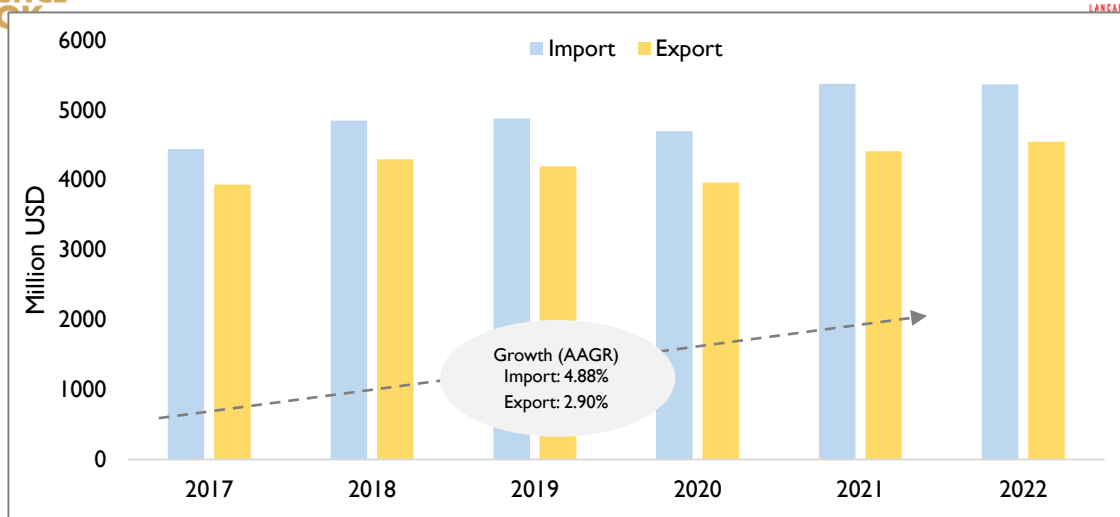


Figure 2f Plastic Product import-export value of Thailand 2017-2022
Source: Thai Customs Source (n.d.)

The main trading partner for Thai plastic products in the export sector in 2022 was Japan, with a market value share of 17.62%, compared to the overall export value. The next top countries were the United States, Vietnam, China, and Indonesia, respectively. On the other hand, in the import sector in 2021, the main trading partner for Thailand was China, with a market value share of 41.90%, followed by Japan, Malaysia, Taiwan, and Vietnam, respectively.

In 2017 Thailand had the highest proportion of plastic product exports in the plastic packaging group, accounting for 46.00% of Thailand's total plastic product exports, followed by the automotive parts industry group, the electrical and electronics parts group, and household appliances group. In 2022 the ratio increased to 54.14% of Thailand's total plastic product exports. Thailand imported the most plastic products in the plastic packaging group, accounting for 43.70% of the total value of plastic product imports in Thailand, followed by the construction material component group, automotive industry component group, and electrical and electronics component group, respectively. In 2022, it was 42.06% of the total value of plastic product imports in Thailand.

Global Trading Situation

Plastic product import – export value proportion in 2022

The overall global export and import of plastic products from main Asian countries were shown in Table 1a and Table 1b, respectively.

Table 2a Plastic product export value proportion in 2022 Currency: USD

Country	Plastics Product	Plastics Packaging	% Share
World	468,978.7	178,992.7	38%
China	107,589.4	35,679.5	33%
Japan	13,860.6	5,089.2	37%
South Korea	11,894	4,820.8	41%
Vietnam	7,232.4	2,738.8	38%

Country	Plastics Product	Plastics Packaging	% Share
Thailand	4,545.0	2,460.7	54%
Singapore	2,652.6	977.8	37%
Cambodia	556.2	99.0	18%
Myanmar	85.9	46.7	54%
Lao	4.8	2.8	58%

Source: Plastics Institute of Thailand (n.d.)

Table 2b Plastic product export value proportion in 2022 Currency: USD

Country	Plastics Product	Plastics Packaging	% Share
World	414,379.2	159,796.3	39%
China	19,057.7	7,075.5	37%
Japan	10,553.8	4,671.3	44%
Vietnam	7,916.5	2,912.3	37%
South Korea	7,704	3,316.4	43%
Thailand	5,365.1	2,256.5	42%
Singapore	3,520.6	1,396.7	40%
Cambodia	960.1	383.0	40%
Myanmar	688.6	265.9	39%
Lao	209	100.9	48%

Source: Plastics Institute of Thailand (n.d.)

China is the country that exports the most plastic products, with an export value of 107,589.4 million US dollars, accounting for 22% of the total value of plastic product exports worldwide. China is a major exporter of plastic products and has increasingly incorporated technology into its manufacturing sector, producing a variety of products. However, in some ASEAN countries the ratio of plastic packaging export, exceeding 50%, is higher than that of China (33%). The packaging industry could be a key industry that creates value for the country and is also a group of products that continues to have an increasing market demand trend.

China is also the country with the highest import of plastic products in Asia. China's imports of plastic products are worth more than 19,057.7 million US dollars or about 4% of the total value of plastic product imports worldwide. China is a large country and has a huge consumer market, so plastic products are imported to meet the demand in the market and the industry. However, some countries in Asia, e.g. Japan, South Korea, And Thailand, have imported plastic packaging products with the higher ratios than China. The packaging industry is a group of products that have high consumer demand, partly due to COVID-19 pandemic. The increasing demand for packaging products, including the economy in countries that gradually recover from tourism and private consumption allows the plastic packaging industry associated with food and beverages to continue to grow continuously.

Global Plastic Packaging Market by Application

In 2021, the food and beverage application segment dominated the market and accounted for more than 51.5% of the industry's total revenue of \$355B. Due to its convenience, single-serving packaging for consumption goods has experienced significant growth in recent years. Increasing consumer focus on health and well-being, heightened awareness of waterborne diseases,

and rising purchasing power have accelerated the global demand for packaged drinking water, which is anticipated to have a positive effect on them.

In addition, the growing production of generic pharmaceuticals is expected to increase demand for plastic packaging in the pharmaceutical application segment. An increase in the utilization of shipping containers and import/export activities has also fueled the growth of the industrial packaging segment. During the period from 2022 to 2029, the introduction of innovative packaging solutions such as active packaging, modified atmosphere, consumable, and bioplastic packaging will provide market participants with lucrative opportunities.

2.2 The Global Use of Plastics

Growing populations and rising per capita incomes have seen the global use of plastics, including additives and fibres, reach 460 Mt in 2019. The used volumes of these synthetic polymers have been increasing more rapidly than any other commodity, including steel, aluminium and cement. In 2020, the COVID-19 pandemic had significant impacts on plastics use which declined in 2020 but rebounded largely in 2021. Two-thirds of plastic current use is concentrated in OECD countries and China. China, USA, and the OECD Europe represent around 20%, 18%, and 18% of global plastics demand, respectively. The rest of the OECD countries represent around 9%.

The majority of plastics in use today are virgin plastics, made from crude oil or gas. Due to the fossil-based feedstock and the high energy consumption during refining, most greenhouse gas (GHG) emissions from plastics can be attributed to the production stage. Biobased plastics are a rather small group of plastics with similar characteristics to fossil-based plastics, but are derived from biomass. Together fossil-based and biobased plastics can be referred to as primary plastics. Plastics made from recycled material are called secondary plastics. Secondary plastics contribute less to GHG emissions than primary plastics, but only accounted for 6% of global plastics use in 2019.

The variety of different polymers that can be produced accounts for the versatility of plastics. The most used polymers are shown In Table 2c. Different polymers have differing properties.

Table 2c The large range of polymers allows for a multitude of plastics applications

Polymer	Abbreviation	Examples of use
Polypropylene	PP	Food packaging, automotive parts
Low-density polyethylene	LDPE	Reusable bags, food packaging film
High-density polyethylene	HDPE	Toys, shampoo bottles, pipes
Polyvinylchloride	PVC	Window frames, floor covering, pipes, cable insulation
Polystyrene	PS	Food packaging, insulation, electronic equipment
Polyethylene terephthalate	PET	Beverage bottles
Polyurethane	PUR	Insulation, mattresses
ABS, elastomers, biobased plastics, PBT, PC, PMMA, PTFE, ...	Other	Tyres, packaging, electronics, automotive, ...
Fibres made of different polymers	Fibres	Textile applications but also in many other sectors

Note: ABS stands for Acrylonitrile butadiene styrene, PBT for Polybutylene terephthalate, PC for Polycarbonates, PMMA for Poly (methyl methacrylate) (also known as plexiglas) and PTFE for Polytetrafluoroethylene.

Source: OECD (2022)

Together, packaging (31%), construction(17%), and transportation (12%) applications account for more than 60% of total plastics use. The other main applications of plastics use include

textiles, household consumer products and non-household or institutional products, electronics, machinery and tyres. Regional plastics use per capita varies greatly: an inhabitant of the United States uses 255 kg of new plastics every year on average, while the average person in Sub-Saharan Africa uses less than one tenth of that amount. In contrast, the range of plastics intensity relative to GDP across the world is smaller, ranging between 2.5 and 4.5 tonnes per million USD (t/M\$). OECD plastic intensity reaches 3.7 tonnes per million USD, while non-OECD countries reach 3.4 tonnes. This correlation is also found in plastics use per capita, whose OECD level is 156 kg per capita, compared to 39 kg per capita for non-OECD countries.

2.3 The current plastics lifecycle (far from circular)

Population growth and higher incomes have driven up global plastics production, which has doubled, soaring from 234 million tonnes (Mt) in 2000 to 460 Mt in 2019. In this same period, the growth of plastics volumes outpaced economic growth by almost 40%. Global annual plastic waste has more than doubled, from 156 Mt in 2000 to 353 Mt in 2019. Almost two thirds of all plastic waste come from applications with lifespans of less than five years: packaging (40%), consumer products (12%) and textiles (11%). Only 55 Mt of this waste was collected for recycling, but 22 Mt ended up as a recycling residue that needed further disposal.

2.4 Plastic waste generation

The generation of plastic waste is strongly related to how plastics are used. The overall average lifespan of a plastic product is almost ten years, though this depends on its use. Packaging has an extremely short average lifespan while plastic applications in the construction sector may be in use for several decades. Therefore, packaging waste constitutes a large share (42%) of total plastic waste generated. According to the OECD Global Plastics Outlook Database, the plastic waste generated in 2019 amounted to 353 Mt.

At the waste stage, the ease of recycling and the potential mobility when lost to the environment are influenced by polymer type, dimensional shape, object size, additive mix, and the items and materials appended in assembly. The predominance of PP, LDPE and HDPE has become even greater in the waste stage because they are often used for packaging applications with short lifetimes. Similarly, since PET is mainly used for packaging, it will become waste rapidly after its initial use. By contrast, PVC and PUR are mainly used for applications with long lifecycles. The polymers with long life cycles account for a relatively high share of the stock of plastics that is present in the economy. The OECD Global Plastics Outlook Database indicates that the OECD generates almost half of all plastic waste: the United States accounts for 21%, OECD Europe 19% and the remaining OECD countries 9%. Outside the OECD, China produces 19% of global plastic waste, India 5% and the rest of the world 27%.

In terms of waste per capita, the United States had the largest plastic waste footprint in 2019, at 221 kg per capita, while OECD Europe had 114 kg plastic waste per capita. Japan and Korea's plastic waste generation is relatively low for industrialised countries, averaging 69 kg per capita. Finally, China generated 47 kg of plastic waste per inhabitant in 2019, while India generated only 14 kg per inhabitant.

2.5 Plastic waste management varies across the world

The end-of-life fate of plastics depends on the local waste management capacities and regulations. The OECD Global Plastics Outlook Database contains five different waste handling categories (recycling, incineration, landfilling, mismanaged waste and littered waste). Unfortunately, plastic waste is often improperly managed. The treatment category “mismanaged waste” aims at quantifying the end-of-life plastics generated in areas where state-of-the-art waste collection or treatment facilities are not in place. The plastic waste is either not collected, collected but disposed of in dumpsites, or collected for disposing in the environment. The “littered waste” category refers both to littering (i.e. when users discard packaging or other products into the environment), and to fly-tipping (i.e. plastic waste generators who consciously circumvent legislation to discard larger volumes of, for example, construction waste into the environment). Litter can either be collected via street sweepings and other clean-up actions or be left uncollected and leak into the environment. In most cases, differences in waste management capacities are related to regulations, geographical and demographic characteristics and other variables. In low-income countries, economic growth can outpace improvements in collection and disposal capacity, leading to increased volumes of mismanaged waste. By contrast, low-income countries typically have low labour costs that make collection and high-quality sorting of recyclables by manual labour economically feasible.

Globally, 15% or 55 Mt of plastic waste were collected for recycling in 2019.7 EU countries, as well as China, India, Japan and Korea have above-average recycling rates. Key drivers of recycling in Europe, Japan and Korea are extensive separate collection facilities and extended producer responsibility (EPR) schemes. In other parts of the world, the informal economy is the main driver of recycling, incentivised by the value of some of the plastics.

Globally, almost 40% of plastics collected for recycling, or close to 22 Mt, are lost during recycling and end up being incinerated, landfilled or mismanaged. When formal waste collection is funded by government and free to users, it typically contains large amounts of un-recyclable plastics and non-plastics which need to be removed. These are counted as recycling losses. By contrast, in informal waste systems, waste pickers selectively target high-value plastics at the point of collection reducing the mass lost when they are cleaned and sorted to get the maximum price. Therefore, there are important regional differences in recycling both in terms of volumes as well as in practices used.

For many emerging economies, lack of technical capacities, poor governance and insufficient financial resources at the municipal level are major bottlenecks in improving waste management practices. Globally, approximately 79 Mt (73 Mt of waste and 5 Mt of recycling residues and 1 Mt of collected litter) are mismanaged annually. Around 43% of that amount (34 Mt) is estimated to be captured in the inner part of dumpsites where degradation and interaction with the environment is close to zero. One-third (26 Mt) is burned in open, uncontrolled fires. The remainder is considered to be lost to terrestrial and aquatic environments. Littered waste is a specific category of improper waste handling that unfortunately is still a problem throughout the world, even in mature economies. The amount of littered waste was more than 4 Mt globally in 2019.

2.6 Plastic Packaging in Southeast Asia and China

- Preventing waste from entering the ocean through Southeast Asia and China is key to addressing the global plastic emergency

Plastic pollution has become a global crisis. Every year, on average 8 million tonnes of plastic enters our oceans. This vast quantity will stay in the environment for hundreds of years, gradually decomposing into countless tiny particles known as microplastics. This has serious consequences for marine life. Around 80% of the plastic in our oceans originates on land, with a significant proportion entering the sea via rivers. Plastic waste on land is also a major problem – from despoiling the visual environment, to toxic pollutants leaching into soil and water, to air pollution caused by incineration. Carbon emissions associated with plastic, from production to burning, reached 860 million tonnes in 2019 – greater than the annual emissions of Thailand, Vietnam and the Philippines combined.

Preventing plastic waste from entering nature requires both upstream and downstream solutions – from eliminating unnecessary plastic use and using more recycled and recyclable materials, to setting up and operating effective waste management systems. Packaging is the dominant user of plastic, and accounts for about half of the world’s plastic waste.

2.7 The Waste Management Challenge

- Inadequate waste management systems are the primary cause of plastic pollution in Southeast Asia and China

Plastic ends up in the environment because of inadequate systems for collecting and treating waste, particularly in the developing world. In low-income countries, 93% of waste is dumped somewhere in the environment, compared to just 4% in industrialized countries. Waste collection rates in developing countries are often below 50%. Single-use plastics and packaging for consumer goods are driving the increase in plastic pollution.

In Southeast Asia and China, rapid economic growth has led to an immense increase in the use of plastic, especially for packaging consumer goods. Unfortunately, waste management systems in the region have not kept pace. In China and Thailand, for example, only around half the waste is collected. Segregation of waste is rare, and very little municipal waste is recycled. When recycling does happen, it usually depends on the informal sector, private enterprises or community initiatives. With the volume of plastic packaging in Southeast Asia continuing to increase, there is an urgent need to put in place effective systems for collecting, sorting, recycling and disposing of waste. As well as being the most effective way of preventing plastic from leaking into the environment, this presents economic opportunities in waste management and secondary materials sector. Setting up the necessary infrastructure requires significant investment, and ongoing financial resources are needed to operate an effective waste management system.

Extended Producer Responsibility

- Ensuring that companies take responsibility for the full life-cycle impacts of their plastic products and packaging can strengthen waste management, reduce pollution, and drive smarter design and materials use

One effective solution is the concept of extended producer responsibility (EPR). Essentially, this means that those who place packaged goods (as well as products such as electrical appliances and batteries) on the market bear the cost of their collection, treatment, recycling and disposal. More than 30 countries, mainly in Europe but also including Japan and South Korea, have implemented EPR programmes, and around 400 schemes exist worldwide. EPR schemes are usually managed by a collective system operator, sometimes known as a producer responsibility organization (PRO). Companies pay a fee to this organization for the packaging they introduce onto the market, and the PRO is then responsible for organizing collection and further processing

of the packaging waste, as well as for communicating with consumers. The system operator will usually contract out waste management services to third parties, potentially including those in the informal sector such as waste pickers. PROs may be private companies, not-for-profit organizations or public sector agencies; some EPR schemes involve more than one competing operator.

EPR schemes can help address the shortfall in financial resources for waste management that leads to plastic pollution. Introducing mandatory EPR policies, rather than relying on voluntary action by individual companies, provides a level playing field for business as well as creating economies of scale. EPR schemes also help reduce plastic consumption by incentivizing producers to design more resourceefficient products with lower environmental impacts. Several countries in Southeast Asia have taken first steps toward implementing EPR schemes. To date, however, these mostly concern e-waste rather than packaging.

2.8 Shared Responsibility

- Governments and companies in Southeast Asia and China need to work together to solve the plastic crisis

Improving waste management for plastic packaging in Southeast Asia and China is vital for stemming the tide of marine plastic pollution – and, in the longer term, for moving towards a sustainable circular economy. Table 2d summarizes the role of the governments, companies, and consumers in shared responsibility.

Table 2d shared responsibility by governments, companies, and consumers.

Governments should	Companies should	Consumers should
1) Set national targets for waste collection, segregation and recycling, and invest in national/regional waste management infrastructure. 2) Create a coherent and transparent EPR framework within national legislation that takes account of local characteristics, such as the role of the informal sector, while promoting a global treaty against plastic pollution on an international level. 3) Monitor companies' plastic use and enforce EPR legislation, creating a level playing field for all companies.	1) Reduce unnecessary use of plastics and transparently disclose the amount of plastic packaging they are putting on the market, e.g. via WWF's ReSource platform (resource-plastic.com) or joining the national PACT initiative. 2) Take responsibility for products' end-of-life impacts, from the design and choice of materials through to collection, sorting, recycling and disposal. 3) Support the creation of EPR schemes, and work with governments and other partners to improve waste management systems and raise consumer awareness.	1) Call on companies to demonstrate leadership by reducing dependency on single-use and unnecessary plastics, taking responsibility for the end-of-life impact of their packaging, and investing in environmentally sound alternatives. 2) Reduce consumption of unnecessary plastics and select reusable or recyclable packaging – and do reuse or recycle it. 3) Ask government representatives for better waste management infrastructure and eco-design, and show support for the creation of EPR schemes.

Chapter 3 Laws & Regulations and Policies related to Plastics Packaging

3.1 Overviews of global plastics packaging

While the packaging is often necessary to protect products, everyone in the industry is looking for ways to reduce waste and overpackaging. This goal is complemented by efforts to make packaging more sustainable with renewable and recyclable materials. The quest for sustainability unites big brands with responsible consumers and – regulators around the world. In recent years, governments have responded to public concerns by devising rules that seek to tackle packaging waste – single-use plastics in particular – and improve recycling and waste management systems. Many of these new norms will create a worldwide regulative trend that can help promote more sustainable packaging. Table 3a shows a quick look into what various countries is currently doing to reduce packaging waste and how this affects companies and consumers.

Table 3a Examples of packaging waste reducing measures and policies in some countries.

Country	Measure and policy
France	France has set the goal to recycle 100% of plastics by 2025 and phase out single-use plastics by 2040. Plastic packaging for nearly all fruit and vegetables was prohibited from January 2022. Publications can no longer be wrapped in plastic for shipping, fast-food restaurants can no longer have plastic toys and public spaces must provide water fountains to reduce the use of plastic bottles. Plastic straws, cups, and cutlery, and styrofoam takeaway boxes were banned in 2021. Any business that sells cross-border to consumers in France needs to register its packaging with a French recycling scheme. Under the French packaging law, companies pay less for their recyclable packaging.
China	The “plastics restriction” policy introduced by China in 2007 as part of efforts to tackle pollution was upgraded to a “plastics ban” in 2021. All single-use plastic products such as non-degradable plastic bags, disposable plastic straws, disposable plastic tableware, and ultra-thin plastic shopping bags will be prohibited in the country. A five-year roadmap is laid out to restrict the use of plastic products such as shopping bags, straws, and utensils by 2020, 2022, and 2025, respectively. In addition, the fast-food industries, e-commerce, and express delivery companies are required to recycle packaging materials and reduce their usage under a revised law that came into effect in September 2020.
USA (New York)	New York’s statewide ban on single-use plastic bags has been enforced since October 2020. From January 2022, no covered food service provider or store will be allowed to sell, offer for sale, or distribute disposable food service containers that contain expanded polystyrene foam in New York. However, alternatives are allowed as long as they do not contain polystyrene foam. The authorities encourage the use of reusable, recyclable, and compostable items, source reduction, and items made using recycled content where possible.

Country	Measure and policy
Australia	<p>Australia aims to phase out single-use plastics and reach ambitious recycling goals under the 2025 National Packaging Targets. These require that all packaging must be 100% reusable, recyclable, or compostable, 70% of plastic packaging is recycled or composted, and 50% of average recycled content is included in the packaging. These targets will be applied to all packaging that is made, used, and sold in Australia.</p> <p>6 out of 8 Australian states and territories will phase out various types of single-use plastics by 2022 and 2023.</p>
India	<p>A ban on single-use plastics announced by the Indian central government will take effect in July 2022. In addition, plastic packaging waste must be collected and managed in an environmentally sustainable way through the Extended Producer Responsibility of the Producer, Importer, and Brand owner (PIBO).</p> <p>At the same time, the authorities have promoted biodegradable alternatives to plastics. Many food vendors, restaurant chains and local businesses have already started using biodegradable tableware and switching plastic bags to cloth or paper alternatives.</p>
Italy	<p>Italy is one of the first EU countries to oblige manufacturers to inform consumers about their packaging’s material composition and end of life. The purpose of this mandatory environmental labeling is to facilitate the collection, reuse, and recycling of packaging. Producers and suppliers have until June 30th, 2022, to comply.</p> <p>Meanwhile, Italy’s plastic packaging tax is now expected to come into effect in January 2023. The tax was first introduced in 2020 but has been delayed due to the Covid-19 pandemic. It is aimed at single-use plastics, such as bottles, bags, and food containers made of polyethylene, tetra packs, packaging made from expanded polystyrene, rolls of bubble wrap plastic, and plastic caps. The tax will affect a wide range of businesses, including Italian manufacturers, purchasers, and sellers of plastic items as well as importers of goods from non-EU countries. However, recycled plastics and compostable biodegradable plastics are set to be exempt.</p>

Table 3b particularly shows the laws, regulations, and policies for plastic management in some East Asian countries including China, Japan and South Korea. Table 3C particularly shows the laws, regulations, and the policies for plastic management in CMVT countries.

Table 3b laws & regulations and policies for plastic management in China, Japan, and South Korea.

Country	Laws & Regulations, and Policies
China	<p>China National Light Industry Council released the “Guideline for Classification and Label Standard of Biodegradable Plastic Products”. The main purpose of the Guideline for Classification and Label Standard of Biodegradable Plastic Products is to explain the concept and definition of biodegradable plastic and make specific</p>

Country	Laws & Regulations, and Policies
	<p>requirements for the biodegradable plastic label in five aspects, the scope, the definition and classification of products, the measurement methods for degradation performance, the requirements of the label, and the styles and standards of the label. This guideline requires that enterprises that produces or sales relevant products or use relevant products such as retailers or restaurants should implement the national policies and measures for combating plastic pollution, and enhanced the management of labeling and procurement for relevant products based on the requirements of the guideline.</p>
Japan	<p>In Japan, “Resource circulation strategy for plastics” was developed to reduce the use of single-use plastics and promote the development and use of substitutes for petroleum-based plastics in 2018. The specific goals with timelines include the cumulative 25% reduction of single-use plastics generation by 2030, reusable and recyclable design for all containers and packaging/products by 2025, 60% recycling rate of plastic containers and packaging by 2030, 100% effective use of used plastics by 2035 including circular economy measures, doubling use of recycled materials by 2030, and maximum introduction (2 million tons) of biomass plastics by 2030.</p> <p>The Containers and Packaging Recycling Law (CPRL) focus on subsidize recycling for municipalities, provide municipalities with recyclers and increases the volume of plastic waste recycling in municipalities. In this law, Manufacturers have to been assigned the responsibility of recycling these containers and wrapping in accordance with the volume that they manufacture or sell, a government-designated organization, operates recycling business on behalf of the specified business entities that pay "recycling fees" to the Japan Containers and Packaging Recycling Association (JCPRA).</p>
South Korea	<p>The Act on the Promotion of Saving and Recycling of Resources (the Resource Recycling Act) has Article 9-2 (Improvement, etc. of Quality and Structure of Packing Materials) stated that the Minister of Environment shall determine and publicly notify standards for improvement, etc. of the quality and structure of packing materials, to ease the recycling of such materials, and producers obligated to recycle under Article 16 (1) shall comply with such standards. A ban will be imposed on PVC plastics and colored PET bottles, which have an extremely negative impact on the recycling process.</p>

Table 3c laws & regulations and policies for plastic management in CLMVT countries.

Country	Laws & Regulations, and Policies
Cambodia	<p>Food producers, processors and packers have to compliance with all food technical regulations, minimum food requirements, including safety, labelling, packaging, advertising and hygiene. Wholesalers and distributors must also meet similar requirements, emphasizing storage and transport.</p> <ul style="list-style-type: none"> • Royal Kram No.NS/RKM/0622/006 • Environmental Guidelines on Solid Waste Management in Kingdom of Cambodia (2006)

Country	Laws & Regulations, and Policies
Laos	Laos has to implement further regulations on plastic waste management and also has to specify, enforce and monitor the already implemented laws and regulations. In February 2019 the Government of Lao approved a National Green Growth Strategy 2030 aimed at strengthening the balance between economic expansion, environmental protection, and social development to ensure the maintenance of high, stable, sustained, and durable economic growth. One of National Green Growth targets is to decrease emissions, pollution, and waste. One of National Green Growth focuses is also on implementing financial mechanisms to help entrepreneurs utilize material-saving technologies, including recycling.
Myanmar	Now Myanmar doesn't have specific law about plastics packaging law. Myanmar only has Notification No.8/2022 concerning the announcement of the labelling requirements for prepacked foodstuff from The National Food Law, Myanmar Food and Drugs Authorities of the Ministry of Health. The notification provides the labelling requirements for prepacked foodstuffs to be in line with international and regional standards.
Vietnam	The Ministry of Health of The Socialist Republic of Vietnam announced technical standards/Regulations including QCVN 12-1:2011/BYT 'Plastics' to provide specifications and requirements for plastic packaging in Vietnam. The Vietnamese government established Decree No. 08/2022/ND-CP Detailing several Articles of Law on Environmental Protection 2020 which came into effect on the same day. Article 64 of Chapter 5 "Waste Management" of the Decree stipulates regulations for plastic products. Specifically, a roadmap for control of the manufacture and import of single-use plastic products has been set out. In decree no. 08/2022/ND-CP, After January 1, 2026, the manufacture and import of poorly degradable plastic bags of 50cm x 50cm or smaller and 50µm thick or less shall be prohibited excluding the export goods. Business entities that manufacture or import single-use plastic products and/or poorly degradable plastic packaging materials shall implement the recycling and treatment obligation under the Extended Producer Responsibility (EPR). After December 31, 2030, the manufacture and import of the following products shall be prohibited: Single-use plastic products (excluding Vietnam Green Label certified products), poorly degradable plastic packaging materials (including poorly degradable plastic bags, and plastic foam containers for food packing), products containing microplastics.
Thailand	Several laws and industrial product standards have been announced. <ul style="list-style-type: none"> • Announcement of the Ministry of Public Health, No. 435, B.E. 2565 (2022) on the quality or standard of plastic containers • Notification No.92/2528 (1985) Regulation (mandatory standard) for Food manufacturer about Quality standards for food packaging. • TIS 655 Part 1-2553 (2010) Plastic utensils for the food part 1 Polyethylene, Polypropylene, Polystyrene, Poly (Ethylene Terephthalate), Poly (Vinyl Alcohol), and Poly (Methyl Pentane) • TIS 655 Part 2-2554 (2011) Plastic utensils for the food part 2 poly (Vinyl Chloride) polycarbonate polyamide and poly (Methyl methacrylate)

Country	Laws & Regulations, and Policies
	<ul style="list-style-type: none"> • TIS 655 Part 3-2554 (2011) Plastic utensils for the food part 3 acrylonitrile-butadiene-styrene and styrene-acrylonitrile • TIS 1136-2559 (2016) Stretch cling film for food. • TIS 2493 Part 1-2554 (2011) Plastic food containers for microwave oven part 1 for reheating • TIS 2493 Part 2-2556 (2013) Plastic food containers for microwave Part 2 for single reheating • TIS 2921-2562 (2019) Melamine - Formaldehyde urea – Formaldehyde

Chapter 4 Circular Economy (CE) Concept and Implementation

The overview of circular economy (CE) concept and implementation from various continent in the world is summarized. Table 4a describes the circular economy concept and implementation in European Union and some OECD countries.

Table 4a Circular Economy (CE) Concept and Implementation in European Union and some OECD countries.

Country	Circular Economy (CE) Concept and Implementation
European Union	EU has started to ban single use-plastics since 2021. Approximately, ten product categories have been banned which are 1) Cotton bud sticks 2) Cutlery, plates, straws and stirrers 3) Balloons and sticks for balloons 4) Food containers 5) Cups for beverages 6) Beverage containers 7) Cigarette butts 8) Plastic bags 9) Packets and wrappers 10) Wet wipes and sanitary items. Besides the ban policies, the EU aims to transition to a circular economy by moving away from the linear “take-make-use-dispose” model. In a circular economy, the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste is minimized. To accelerate the EU’s transition to a circular economy, the European Commission adopted the new circular economy action plan in March 2020. plastic packaging recycling of 50% by 2025 and of 55% by 2030. In addition, the European has the EuCertPlast Certification, a European wide certification program, for companies that recycle post-consumer plastic waste.
France	France has set the goal to recycle 100% of plastics by 2025 and phase out single-use plastics by 2040. Plastic packaging for nearly all fruit and vegetables has been prohibited since January 2022. In addition, publications can no longer be wrapped in plastic for shipping, fast-food restaurants can no longer have plastic toys, and public spaces must provide water fountains to reduce the use of plastic bottles. Plastic straws, cups and cutlery, and Styrofoam takeaway boxes have already been banned in 2021. Any business that sells cross-border to consumers in France needs to register its packaging with a French recycling scheme. Under the French packaging law, companies pay less for their recyclable packaging
Italy	Italy is one of the first EU countries to oblige manufacturers to inform consumers about their packaging’s material composition and end-of-life. The purpose of this mandatory environmental labeling is to facilitate the collection, reuse, and recycling of packaging. Producers and suppliers have to comply, started in June 30th, 2022. Italy’s plastic packaging tax was now to come into effect in January 2023. It is aimed at single-use plastics, such as bottles, bags, and food containers made of polyethylene, tetra packs, packaging made from expanded polystyrene, rolls of bubble wrap plastic, and plastic caps. The tax will affect a wide range of businesses, including Italian manufacturers, purchasers, and sellers of plastic

Country	Circular Economy (CE) Concept and Implementation
	items as well as importers of goods from non-EU countries. Recyclable plastics and compostable/biodegradable plastics are tax exemption.
The Netherlands	The country bans single-use plastic and free plastic carrier bags. Municipalities are responsible for the collection of plastic packaging waste in the Netherlands. In the Netherlands plastic packaging waste collection differs per municipality. Depending on what they choose, municipalities can use source separation or post separation. Around 90% of municipalities in the Netherlands uses source separation, the rest use post separation or a mix of both systems (KIDV). The Dutch Ministry of Infrastructure and Water Management has reached an agreement with the sector on the introduction of a deposit on small plastic bottles by 2021. For PET bottles that are 0,75 liters or larger the Dutch government has already introduced a deposit-refund system. The number of municipalities in the Netherlands that use a Pay as You Throw (PAYT) System is rising. Plastic packaging in the Netherlands is sorted according to DKR standards. These standards describe the material, indicate the minimum purity of the material, determine the maximum contamination and specify the delivery method. Within the specifications applied in the Netherlands, PET falls under DKR standard 328-1, PE under standard 329, PP under standard 324, films under standard 310 and mixed plastic under standard 350.
Australia	Australia aims to phase out single-use plastics and reach ambitious recycling goals under the 2025 National Packaging Targets. It requires all packaging 100% reusable, recyclable, or compostable, 70% of plastic packaging is recycled or composted, and 50% of average recycled content is included in the packaging. These targets will be applied to all packaging that is made, used, and sold in Australia. 6 out of 8 Australian states and territories will phase out various types of single-use plastics by 2022 and 2023.
Canada	In 2021, the Canadian government drafted the single-use plastics prohibition regulation (SUPPR). SUPPR aims to prohibit the manufacture, import, and sale of six categories of single-use plastics, including checkout bags, cutlery, and ring carriers. Canada set a target to make zero plastic waste by 2030 and help reduce greenhouse gas emissions. The Regulations prohibit the manufacture, import, and sale of 6 categories of single-use plastics such as Checkout bags, Cutlery, Foodservice ware, Ring carriers, Stir sticks, and Straws.

In addition, CE concepts have been implemented in private sectors. The examples given in this summary are Nestle and Coca-Cola companies. Nestle is committed to designing 100% plastic packaging for recycling. Now, 85.8% of its total packaging is already recyclable or reusable. Out of this, 81.9% of its plastic packaging is designed for recycling in dedicated recycling facilities. Nestle is on track to reduce its use of virgin plastics in packaging by one-third by 2025 and is pioneering alternative packaging materials to facilitate recycling. Packaging plays an important role in safely delivering high-quality food and drinks to consumers, and in reducing food loss and waste. By 2025 Nestlé will make 100% of its packaging recyclable or reusable and reduce its use of virgin plastic by one-third. In 2018, The Coca-Cola Company (TCCC) declared its vision to

work towards a "world without waste" by launching a global initiative under this name to dramatically reduce the environmental impact of packaging. In January of that year, the Coca-Cola system in Japan announced its commitment to "2030 Packaging Vision" in which it laid out a set of environmental targets that align with TCCC's global initiative. To accelerate the progress of this global initiative, the roadmap set in "2030 Packaging Vision" has been renewed in July 2019 with shorter timelines aimed at achieving the targets earlier than the original due dates. The targets of 2030 Packaging Vision Roadmap are to create

Target of 2030 Packaging Vision Roadmap is to achieve at least 50% use of sustainable materials made from recycled PET plastic by 2025, 100% use of sustainable materials in PET bottles of all products being sold in Japan by 2025, 100% use of sustainable materials for the complete implementation of packaging not using fossil fuels by 2030, and 35% reduction of PET plastic used in each product by 2030.

In Asia, the CE and its implementation was summarized in Table 4b.

Table 4b Circular Economy (CE) Concept and Implementation in Asia.

Country	CE concept and implementation
China	<p>The “Guideline for Classification and Label Standard of Biodegradable Plastic Products” clarifies the concept and definition of biodegradable plastic and make specific requirements for the biodegradable plastic label. This guideline was implemented in 2020 by The China National Light Industry Council, the China General Chamber of Commerce, and the China Plastics Processing Industry Association.</p> <p>The General guidelines for the evaluation of plastic products’ easy-to-collect & easy-to-recycle design” (T/CRRA 0302-2020) are used for defines evaluation indicators for plastic products’ easy-to-collect & easy-to-recycle design, mainly focusing on the standard specifies the evaluation index system and evaluation methods for easy-to-collect & easy-to-recycle design and applies to the guidance and evaluation process of easy-to-collect & easy-to-recycle design of plastic products. This General guideline for the evaluation of plastic products’ easy-to-collect & easy-to-recycle design” (T/CRRA 0302-2020) was implemented in February 1, 2021, by China National Resource Recycling Association (CRRA).</p>
Japan	<p>In Japan, more than 9 million tons of plastic waste were generated in 2017. More than 50% of plastic waste was treated by incineration with power generation and heat recovery, refuse-derived fuel, and auxiliary fuels in cement kilns, while the material recycling accounted for only 23%. In Japan, “Resource circulation strategy for plastics” was developed to reduce the use of single-use plastics and promote the development and use of substitutes for petroleum-based plastics in 2018. Japan established the Containers and Packaging Recycling Law (CPRL) which aims to subsidize recycling for municipalities, providing municipalities with recyclers and increasing the volume of plastic waste recycling in municipalities.</p>
South Korea	<p>South Korea established the EPR system for packaging waste in South Korea for make zero plastic waste by 2030 and help reduce greenhouse gas emissions. This</p>

Country	CE concept and implementation
	<p>EPR system focuses on the manufacture, import, and sale of 6 categories of single-use plastics such as PET bottles, cutlery, foamed synthetic resin (EPS, PSP, etc.), other synthetic resin (container/ tray) other synthetic resin (film/sheet) and metal cans, glass bottles, carton packs. The Producers should annually collect and recycle their assigned quantities corresponding to the recycling mandatory rate notified by the Korea MOE based on the 5-year long-term recycling target rate. Producers can fulfill their obligations by joining Korea Packaging Recycling Cooperative, a producer responsibility organization (PRO). The EPR system for packaging waste in South Korea was implemented in 2003 by the government of Korea.</p>
Cambodia	<p>Cambodia has three main policies about the circular economy that use in country. First is the National Environment Strategy and Action Plan (NESAP) 2016-2023 developed in accordance with the Constitution and 1996 Law on Environmental Protection and Natural Resource Management. Second is Sub decree on Urban solid waste management is Tasks sub-national administrative units with the responsibility of preparing annual waste management action and budget plans, coordinating waste service provision with the private sector, determining appropriate fees for waste services, generating source revenue through the collection of service fees, and accessing financial resources from central authorities inter alia. Third is Law on environmental protection and natural resources. The law designates that the Ministry of Environment is tasked with formulating policies towards waste management and pollution control.</p>
Laos	<p>Laos encourages and promotes domestic and foreign investors to make investment in waste-related business activities in order to reuse the wastes or to use them as raw materials for producing various items so as to create economic value, jobs and income generating activities for the peoples as well as to decrease the use of new natural resources. According to the statistical data, a person in Vientiane Capital has produced waste, on average, of 237 kgs per year; about 70% of this waste can be reused. At present, only 10% of this waste is collected for reuse. The Ministry of Industry and Commerce, Lao PDR published the “Decision on the list of prohibited goods for importation or exportation No. 0848 / MOIC” in the Gazette on 17 September 2021. The prohibited list of the goods for importation or exportation refers to the prohibited goods for either import or export in order to protect the national security; social order; ethics; culture; lives and health of the people, animal or plants; to protect the national heritage; natural resources or to comply with the international conventions.</p>
Myanmar	<p>The Mandalay City in Myanmar banned the manufacture, import, trading and distribution of HDPE (High-density Polyethylene) plastic bags in some municipalities in 2009. The Yangon City Development Committee (YCDC) of Myanmar officially announced to ban businesses from manufacturing, importing, trading, or distributing high-density polyethylene (HDPE) plastic bags for environmental reasons. Yangon also attempted not to allow the production, storage and sales of non-biodegradable waste such as polyethylene bags and ropes in April 22, 2011.</p>

Country	CE concept and implementation
Vietnam	Vietnam is facing diverse environmental issues due to its rapid economic growth and industrialization. The “Resolution No. 35/NQ-CP on a number of urgent issues in environmental protection”, which was promulgated in 2013, has identified seven issues as the country’s challenges. On October 28, 2020, the Ministry of Natural Resources and Environment of Vietnam issued the “Decision 2395/QD-BTNMT of the Ministry of Natural Resources and Environment to implement the ‘Prime Minister Directive 33/CT-TTg on strengthening management, reuse, recycling, treatment, and reduction of plastic waste’ and the ‘Prime Minister Decision 1746/QD-TTg of on introducing national action plan for management of marine plastic waste’”. The purpose of this decision is to embody and effectively implement the goals set by 2020 Directive 33/CT-TTg and Decision 1746/QD-TTg and the measures to achieve the goals. In addition, the Law on Environmental Protection 2020, which became effective on January 1, 2022, has introduced “pay as you throw” policies; it requires the segregation of wastes; and it sets out the legal basis for extended producer responsibility (EPR) schemes. Vietnam has also set targets for phasing-out SUPs. On January 1, 2026, production (for domestic consumption), as well as imports of non-biodegradable plastic bags will be banned. In addition, the decree directs Provincial People’s Committees (PPCs) to restrict the distribution and use of SUPs in shopping centers, supermarkets, hotels, and tourism areas, starting in 2025.

As for Thailand which has been tackling with various environmental pollution issues emerging along with economic growth. Social interests on the management of increasing wastes, including municipal wastes, industrial wastes, waste electrical and electronic equipment, infectious wastes, as well as noise and odor issues has risen. Table 4c summarizes the national strategies and policies related to waste management and CE concept and implementation.

Table 4c national strategies and policies related to waste management and CE concept and implementation in Thailand.

Strategy	Explanation
The National Strategy 2018 – 2037	The National Strategy 2018 – 2037 outlines the first level plan to drive towards the achievement and requires that the guidelines be conveyed into the second and third level plans. The country's vision stipulated in the National Strategy was referred to in short as the national motto of "security, prosperity and sustainability". The waste separation behavior of the people would be regarded a part of the sustainability goal. Manufacturing and consumption must consider environmental impacts and comply with the SDGs.
The Twelfth National Economic and Social Development	The Twelfth National Economic and Social Development Plan is an action-oriented plan set within the 20-year National Strategy (2017-2036). According to the strategy for environmentally friendly growth for sustainable development, environmental problems are expected to increase along with economic growth and urbanization. Then, a critical development approach must be carried out to promote sustainable consumption and production related

Strategy	Explanation
Plan (2017-2021)	to waste management, recycling, and circular economy. The goals relating to waste management in this plan consist of; (1) MSW shall be properly managed to 75% of the total generation and (2) to promote environmentally friendly products, life cycle waste management and sustainable production and consumption.
BCG Model	Thailand has designated the Bio-Circular-Green Economic Model (BCG) to make sustainable use of natural resources even as minimizing environmental effects. BCG leverages a whole-of-society strategy, including the government, private sector, academics, and society which have collectively successfully integrated this philosophy into practice. A new BCG model has been developed to support Thailand 4.0 policy as a strategy for driving economic and social development. BCG is a combination of the bioeconomy, the circular economy, and the green economy. Bioeconomy is defined as the manufacturing of renewable biological resources and the transformation of these resources into value-added products. Circular economy aims to reuse and recycle resources. Green-economy focuses on balancing the economy, society, and the environment, resulting in sustainable development.
Roadmap on plastic waste management 2018-2030	Roadmap on plastic waste management 2018-2030 is a holistic policy for managing plastic waste in Thailand for conveyed to organizations for use as a framework for preventing and solving plastic waste problems. The vision of this Roadmap is for moving towards sustainable plastic management through the circular economy. Two targets comprise reduction and replacing some single-use plastic using more environmentally friendly products in 2019-2020, and 100% target plastic waste to the circular economy in 2027. Three measurements under the roadmap are 1) reduce plastic at production, 2) reduce the single-use plastic consumption, and 3) manage plastic waste in the proper system after consumption.

4.1 Circular Economy in Plastics Packaging Trend

The European create a strategy for plastic in circular economy in 2017 and set the target in 2025 that plastic packaging will be recycled at 50% by 2025. In 2020, China starts to launch ban plastic bag policy in major cities and set target that in 2020. Plastic bag is banned in shopping malls, supermarkets, pharmacies, bookstores, and food takeout services. In 2022, Canada announced that they will ban single use plastic (eg. Checkout bags, Cutlery, Foodservice ware, stir sticks and straws) and Pepsi’s European set target to create 100% recyclable in 2022. In 2023, England will ban single use plastic by October 2023. In 2025 many countries have plastics waste circular economy target such as China has target to reduced plastics waste straw by 30%. In USA, 100% of 100% of plastic packaging will be reusable, recyclable, compostable by 2025. Coca Cola and nestle will change all packaging to recyclable material. In 2026, China will ban degradable plastic bags. In 2027, Thailand will be 100% recycled plastics waste. In 2030 Malaysia and South Korea will be zero plastics waste country, Vietnam will ban single use plastics bags, Japan will be 60% of recycling rate, EU will have Plastic Packaging recycling at 55% and all P&G packaging will be 100% recyclable Material. In 2035, Japan will be 100% effective use of plastics.

The circular economy trend of plastics packaging are widely recognized in many countries in the world. Countries that do not have policies or laws to save the environment or prevent plastic pollution from plastics packaging will face obstacle of trade to other country. ASEAN countries should study and create more sustainable policies for managing plastic packaging and plastics waste. Circular Economy is one of the solutions that can make countries in ASEAN create laws and policies about plastics (Table 4d).

Table 4d Summary status quo of CE and plastic choice

	CE	Plastic choice	System
EU	2025: 50% plastic packaging recycling 2030: increase recycling rate to 55%		
French	2025: recycle 100% of plastics 2040: phase out single-use plastics		
Italy	2023:plastic packaging tax		
Australia	2025: phase out single-use plastics 2025: all packaging 100% reusable, recyclable, or compostable, 70% of plastic packaging is recycled or composted, 50% of average recycled content is included in the packaging.		
Canada	2030: zero plastic waste		
Japan	2025: reusable and recyclable design for all containers and packaging/products 2030: -25% reduction of single-use plastics and -60% recycling rate of plastic containers and packaging -maximum introduction (2 million tons) of biomass plastics 2035: 100% effective use of used plastics including circular economy measures		
China	No data	Biodegradable plastic	
South Korea	2030: zero plastic waste		EPR system for packaging waste
Vietnam	No data	Biodegradable plastic	
Thailand	2027: 100% CE of plastic waste	Recyclable plastic	No
India	2022: ban single-use plastics	Biodegradable plastic	

Chapter 5 Case studies Eco design theory and practice

Plastic manufacturers are competitive in price. Today's culture of plastic products is built to compete on price which result in product with similar shape and price. If the industry can differentiate its product, this will create opportunities and create new awareness to consumers. Product groups in the food industry Plastic packaging are among the largest use. For the packaging design, creative design principles have been introduced to add value to household products and attract consumers. By combining art design principles with engineering principles, it can be initiated in a variety of ways. The example include the following.

Color of plastic products: Entrepreneurs should find the way to bring creativity to the color of plastic. Entrepreneurs in the industry can take initiative with minimal cost but can adjust the image of the product for a better look.

Shape of plastic products: When the shape and design of the plastic products are similar, the decision making for consumers to purchase the product would be based on prices. There are limitations to changing the shape of new plastic products due to the costs of developing new molds. Thinking outside the box by applying creative principles will make a difference in the decision-making for consumers. and create added value in product sales.

Function of plastic products: Increasing the functionality of existing products to be more diverse and to meet the needs of today's consumers who want convenience and value for money can add benefit. The obstacle is the investment budget in both molds and other electronic equipment that is higher and requires more expertise in manufacturing than plastic products.

Trend of Eco Design

Many countries around the world have put efforts into reducing wastes both at the source and at the landfill. Bringing waste back to create value added new product is a trend but recycled plastic is often seen as a cheap product with low quality. Therefore, product design principles must be introduced with creative use. This caused a trend that made consumers change their minds and buy products from recycled materials with more markets to support.

Upcycle and Recycle

Recycling process can be described as follows 1) separate and cleaning plastic packaging based on its components and color 2) chop and grind plastic packaging into pellets 3) melt pellets for using as raw materials for producing plastic. The upcycling process is to bring the collected waste to be cleaned and reinvented into new products without going through the process of melting into recycled plastic pellets. The products from the upcycle process will be designed using creative design principles to create new products and gain acceptance in many markets. At present, there is a new trend of using waste to create added value has begun to change consumer behavior.

In Thailand there are many product designers who use the upcycle concept to make products. The large corporate companies in Thailand have begun to be interested in developing products that are manufactured with their own raw materials. Several recycling and upcycling projects are in place. The Plastics Institute of Thailand offers innovative plastic product design and development services for entrepreneurs in Thailand who want to develop products that are Eco designed and compatible with the principles of the Circular economy.

5.1 Extended Producer Responsibility (EPR) of plastics product

EPR is a principle that extends the responsibility of the producer to different stages of the packaging life cycle. It is a guideline for manufacturers to consider the full range of environmental impacts. From design, distribution, take-back, collection, reuse, recycling, and treatment, this principle has already begun to be applied to many large brands as a social and environmental responsibility. EPR is a policy principle that holds producers responsible for the environmental impacts of target products and packaging they put on the market, throughout their entire life cycle, including the post-consumer stage. Various policy instruments can be employed in an EPR system, for instance mandating the take-back of end-of-life products and packaging waste for safe recycling and disposal. The EPR includes implementing take-back and recycling programs for products and packaging, setting up collection points and recycling pickups for products and packaging, and designing new products and packaging that are easier to reuse, upgrade, repair, and recycle. The EPR system in the European Union (EU) may typically be ahead of the curve, especially in Germany, the EU's biggest economy. For the packaging sector, Germany has implemented monetary value to returnable containers at €0.25, or around 9 baht, for each single-use recyclable container e.g. PET bottles and aluminum cans. Packaging refund machines are installed in almost every local supermarket in Germany. With the German Deposit Refund System (DRS), the cost of beverages in Germany has dropped significantly as consumers only pay for the liquid in the packaging and the value of the container is returned to them when they return the packaging at any drop point nearby

Chapter 6 Expert Interviews on CE of plastics products

The interviews of Representative from Pollution Control Department of Thailand (PCD) and of representative from Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics) could be summarized in Table 6a.

Table 6a Interviews session summary regarding CE of plastic products

Pollution Control Department of Thailand (PCD)	Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics)
<p>In 2021, Thailand used 5.68 million tons of plastic pellets, which is the highest amount used for packaging at 41%. There were also 2.76 million tons of single-use plastic waste generated after consumption, which requires management due to the tendency of single-use plastic waste being discarded. Although single-use plastic waste can be recycled, it is not a popular practice due to high contamination levels, lightweight, and difficulty in transportation, leading to marine plastic pollution that impacts the overall environment. The government has taken action to manage this issue by developing a roadmap for plastic waste management and implementing plans for phases I and II of plastic waste management. Phase I focuses on reducing and eliminating the use of seven types of plastic by the end of 2022. The 7 types of plastic are 1) cap seals, 2) plastic with oxo-biodegradable additives, 3) microbeads from plastic, 4) plastic bags with a thickness of less than 36 microns, 5) foam food containers, 6) single-use plastic cups, and 7) plastic straws. According to this policy, out of 7 types of plastic, only cap seals and microbeads could achieve 100 percent ban due to supporting laws/regulation enforcement, while other types of plastic waste are still challenging to control due to limitations in usage control. Therefore, the government has evaluated the results of phase I implementation and revise a plan for</p>	<p>In 2016, there began to be an agenda to address the issue of garbage in the ocean and it was claimed that Thailand was the 6th largest producer of plastic waste in the world. NGOs raised concerns about global warming, plastic waste, and garbage in the ocean, leading to increased meetings, academic presentations, and conferences on these topics by both the government and private sector in Thailand. At the same time, large corporations in Thailand began to engage in CSR, which became a common practice. As all sectors began to participate in more meetings, there was increased awareness and a movement to bring together all relevant stakeholders, including the government, NGOs, and private sector, to form a PPP Plastics organization. It was believed that solving these problems required collaboration from all sectors.</p> <ul style="list-style-type: none"> - Since the establishment of PPP Plastics up to the present, there has been a positive trend toward pushing for management solutions for the aforementioned problems. This is because the government has responded and quickly developed policies. All parties are aware that a linear economy is not the future, but a circular economy is a future for all organizations. - In the name of the business owner, it can be said that Prepack Co., Ltd. is one of the leading organizations that apply CE. They recognized the trend that CE would be a sustainable solution to problems and began investing in

Pollution Control Department of Thailand (PCD)	Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics)
<p>the phase II. Phase II waste management approach prioritizes proper management of waste throughout the product life-cycle, including design, production, distribution, consumption, sorting, recycling, and disposal based on academic principles. The plan includes four measures: 1) control of environmentally friendly production (eco-design), 2) reduce plastic consumption, 3) management of post-consumer plastic waste (sorting into the system), and 4) reduce plastic leaking to the sea/ocean. The plan was approved by the Cabinet and has been implemented since 2018. Additionally, discussions have been held with relevant stakeholders e.g. industrial operators for the entire supply chain, and government agencies such as the Board of Investment and the Plastic Institute, to develop a plastic take back system. Besides manufacturers and government agencies, discussions have also been held for the consumer sides including waste-generating sources, such as department stores, fresh markets, and restaurants. The aim of the discussion was to develop a continuous policy response and address problems caused by the lack of clear laws regarding packaging waste management. The current laws that are relevant to plastic waste management are 1) the Public Health Act and 2) the Cleanliness Act. However, these 2 acts are based on a linear economy management approach that emphasizes only end-of-life waste management.</p> <p>- From the policy that sets clear targets for utilizing plastic waste and increasing stakeholder engagement throughout the entire waste management chain, including the potential for specific legislation and regulations to achieve the objective of bringing unmanaged plastic into the system.</p>	<p>solutions that meet the demands. Prepack was one of the first companies to develop PE with high barrier chemicals for coating films, aiming to replace nylon. Today, many international companies have raw materials that are mono materials with excellent oxygen barrier properties. This demonstrates the good response from other business owners, even if the progress is not immediate.</p> <p>- Several business owners are preparing themselves to invest in technology and research to adapt themselves as recyclable materials and to support the market in the future. However, they still need to listen to customer demands as brand owners have policies and goals to respond to the issues. For example, they set targets that in 2025, their products must be 100% recyclable, or their products should reduce the use of virgin plastic pellets made from fossil fuels by 25%. But due to the current global economic situation, the announced policies have been delayed from the original commitment of 2025 to 2030. Therefore, even though business owners have prepared themselves to invest in technology or research, there are no purchase orders from customers yet.</p> <p>- PPP Plastics is responsible for creating models to demonstrate to the government that if we promote infrastructure for waste segregation from the source, minimize contamination of household waste segregation, create waste collection businesses throughout the entire supply chain, and ensure minimal waste disposal in landfills from waste management, starting from waste separation, waste buyers, and leaving minimal waste for landfills. From past projects such as Rayong Less Waste, it has been proven that this can be achieved and sustained. It is hoped that in the next 5 years, the government will apply successful project models and support</p>

Pollution Control Department of Thailand (PCD)	Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics)
<p>- Additionally, the CE policy is one of the three main pillars aligned with the government's policy of applying the BCG model framework, foreseen as a necessary to achieve sustainable economic and environmental outcomes. Importantly, plastic waste management might be included as a part of trade barriers in the future. In addition, trade barriers may need to be considered by driving with relevant economic organizations. Currently, a bill to promote the CE in packaging is being drafted, which specifies the responsibilities and duties of each agency. However, the enactment of this bill will need to consider the possibility of at which level the law should be enacted to have the most flexible enforcement.</p> <p>- The obstacles to implementing the CE policy include the lack of law enforcement. Voluntary program only might not be able to achieve the CE target as stated in the Roadmap. Besides, the unclear and discontinues communication also part of the factors that affect the CE.</p> <p>- The measurement of the success of CE policies requires a waste database and an MFA study, which are currently underway. If such a database exists, it will enable the establishment of realistic targets, monitoring of results, and clear measurement of policy success.</p> <p>- From the study of foreign countries such as Korea, Taiwan, and Japan, the government has found that these countries have laws that require citizens to practice waste separation. However, the problem in Thailand is that there is no specific responsibility assigned to citizens for waste separation, and only the authority for waste management is designated to local authorities. Therefore, there is a need to push for the enactment of laws that will establish citizen responsibility for waste separation.</p>	<p>Extended Producer Responsibility (EPR), create supportive infrastructure, encourage more use of recycled materials, and establish laws, such as imposing fines on citizens for not separating waste, and assigning everyone the responsibility of managing waste properly. In the industrial sector, efforts should be made to develop materials that can be easily recycled. If both sectors can successfully achieve these goals in the next 5 years, it can be said that they are fully prepared for sustainable waste management throughout the entire supply chain.</p> <p>- The strategy for businesses or industries to create differentiation or increase economic value is to keep up with global trends, follow the country's roadmap, and be able to generate knowledge, understanding, sell ideas, concepts, and develop products that meet the needs. This will lead to gaining new customers and increasing market share.</p> <p>- In terms of the environment, there still needs to be a search for technology that maximizes the use of recycled plastic pellets with desired properties. For example, currently, Post-Industrial Recycled (PIR) technology can only yield up to 3% of recycled plastic pellets without decreasing the quality. If the quantity of PIR can be increased, it will help reduce the environmental impact even more by reusing plastic waste generated during industrial processes.</p> <ul style="list-style-type: none"> • As a managing director of Prepack Co., Ltd., I have set a goal to achieve zero waste, which is considered a challenging goal due to several limitations as mentioned above. For instance, currently, only less than 1% of the entire market is able to handle soft plastic packaging due to the complexity of raw materials and high management costs. However, rigid plastics can be managed more

<p>Pollution Control Department of Thailand (PCD)</p>	<p>Public Private Partnership for Sustainable Plastic and Waste Management (PPP Plastics)</p>
<p>- The Department of Pollution Control believes that enforcing appropriate laws throughout all sectors and clearly defining the roles and responsibilities of all parties involved in the supply chain will accelerate the implementation of the CE concept. A waste plastic database will aid in measuring the effectiveness of policies. Additionally, communication with users, such as using eco-labels, should be encouraged. Furthermore, if manufacturers focus on eco-design principles, such as producing plastic packaging with a single type of raw material for easier post-consumption management, it will be beneficial.</p>	<p>easily as they mainly use the same type of raw materials.</p> <p>- As the chairman of PPP Plastics, the goal is to reduce marine debris. Therefore, in order to achieve this goal more easily, it is believed that the management style of PPP Plastics should be changed to a corporation. This will allow for a core workforce to push and work in the long term, as CE is a long-term issue that must work together with various sectors, including the government. PPP Plastics itself must understand and filter the needs of the industry to have an appropriate approach throughout the entire supply chain and comply with government policies. Only then can there be positive outcomes for the economy, society, and environment.</p>

In addition the interviews, Table 6b summarize the progress and outlook of CE in some Asian countries and European Union based on literature reviews.

Table 6b Progress and outlook of CE in some Asian countries and European Union

Country	Progress and outlook of CE
Thailand	<p>Trend of plastic industries (consumption/waste): Thailand, like many countries around the world, is in the midst of a significant plastic waste crisis. In 2019, the Government of Thailand released the Roadmap for Plastic Waste Management 2018-2030 and is developing the National Action Plan on Marine Plastic Debris to alleviate the current impacts and avert future damage caused by marine plastic debris. While these efforts are critical steps toward reining in the country’s plastic pollution problem, further insight is needed into where the plastic waste comes from and how it moves in the environment.</p> <p>Progress of CE: Production - Ban on plastic cap seal. FDA ban on recycled content in food packaging. This ban is however being reconsidered and is expected to be amended by end of 2020. (The plastics cap seal ban is in reality a voluntary agreement with manufacturers not to use the plastic cap seals.)</p> <p>Consumption- Bans use of single-use plastic bag. (The 2nd Green Public Procurement Plan encourages green consumption within the government.)</p> <p>Disposal- There are no targets for diversion from landfill or landfill bans currently in Thailand.</p> <p>Recycling -There are no Extended Producer Responsibility (EPR), take-back, or source segregation regulations currently in Thailand.</p>

Country	Progress and outlook of CE
	<p>Gaps CE compare with global situations: Despite implementation of a “National Roadmap on Plastic Waste Management 2018–2030”, Thailand has failed to achieve its annual targets. No instrument with wide geographic reach operational aimed at strengthening EPR (extended producer responsibility) on packaging and durables, improving recycling rates by imposing landfill or incineration taxes, and other friendly approaches (deposit refund and pay-as-you-throw). Inequality/inequity in Thailand, as a waste-importing country, processes plastic products from several developed countries, compromising its capacity to develop sustainability measures. The political power by petrochemical industry aggravates domestic inequalities and impedes the ability of government agencies to act cohesively in implementing meaningful environmental reforms.</p> <p>Regulations/Law: General Legislative Framework - Plastic Waste Management Roadmap 2030 outlines plans to eliminate and replace 7 types of single-use plastic with more environmentally- friendly materials by 2022 and recycle 100% of plastic waste by 2027. All plastic waste imports will be banned by 2021.</p> <p>Lesson learns for Thai government: Land-based structural inequities and societal inequalities together pose ongoing obstacles to Thailand's efforts to reduce plastic pollution as problems in the circular economy itself. Geopolitical and economic power imbalances impede the formulation of cross-sector and multi-scalar forms of circular stewardship that are vitally needed to respond to the accumulating impacts of plastic pollution across land and sea boundaries. Major plastic producers and retailers have benefitted the most from such inequities, such as not having to take responsibility for their products.</p> <p>Outlook for future: Sector-specific pathways for more equitable policy choices. For the private sector, Thai companies could emulate or replicate in their collaborations with state and societal partners. Manufacturers can make products which can be better recycled as well as reduce the amount of plastic it uses in its products. For the public sector, the political fragmentation, lack of coordination and incomplete data collation within and between government departments in Thailand signals the need to strengthen state waste management capacities at meaningful scales. EPR mechanisms also need to be introduced and enforced by government institutions. Societal transformations should begin with the transformation of the informal recycling sector into a regulated waste management body. In Thailand where spatial inequalities exclude large sections of society from formal waste management regimes, informal service providers will likely remain essential for many communities. Registering and organising these key stakeholders as waste management providers would better align state and societal interests, thereby enhancing the efficacy of circular activities.</p>
Japan	<p>Trend of plastic industries (consumption/waste): Most plastic pollution comes from inadequate collection and disposal of larger plastic debris known as macro-plastics, but leakage of microplastics (synthetic polymers smaller than 5 mm in diameter) from things like industrial plastic pellets, synthetic textiles, road markings and tyre wear are also a serious concern</p>

Country	Progress and outlook of CE
	<p>Progress of CE: Production - Requires payment of a recycling fee by manufacturers to the designated organisation for recycling.</p> <p>Consumption- The Japanese government has plans to make plastic shopping bag charges mandatory.</p> <p>Disposal - There are no targets for diversion from landfill or landfill bans currently in Japan.</p> <p>Recycling- Act on the Promotion of Effective Utilization of Resources fosters the recycling of reusable resources.</p> <p>Gaps CE compare with global situations: Japan has already applied an extensive policy framework centered around the concept of a Sound Material-Cycle Society, to form the basis of its transition towards a more circular economy. Policy plans such as METI’s Circular Economy Vision 2020 and the MOE’s plastic resource circulation strategy and its concept of a Circular and Ecological Economy, help increase awareness of the circular economy. The Circular Economy Vision 2020, though not as detailed as the EU’s most recent Circular Economy Action Plan, still puts forward some crucial focus points, such as the importance of digitalization, ESG, and an improvement of the market for secondary materials, through measures such as regulation and better cooperation between the upstream and downstream supply chain.</p> <p>Regulations/Law: General Legislative Framework- The Basic Act for Establishing a Sound Material-Cycle Society clarifies the responsibilities of all key stakeholders, and articulates fundamental matters for making policies for the formation of a Sound Material-Cycle society.</p> <p>Lesson learns for Thai government: The role of non-governmental stakeholders should not be forgotten, as involving civil society and business communities is key in achieving a circular economy. Though the remanufacturing, repair, reuse, and products as a service are still smaller sectors in Japan, circular business models are commercially viable and that innovative European circular solutions would also be attractive for a Japanese market and Thai market as well. There are several organisations and media companies now specially focused on promoting the circular economy in Japan. The importance of public-private partnerships cannot be underestimated either for combating plastic waste being successful in uniting cross-sectorial stakeholders from the entire supply-chain, and showing a clear way forward. In addition, a law charging consumers for single-use plastic bags entered into force in July 2020 which is a step in the right direction. Although it is as of yet too early to assess the impact of the policy, early data from the three largest convenience store chains in Japan sees that consumers declining to pay for bags as high as 75-77%.</p> <p>Outlook for future: In order to accelerate the transition to the circular economy, key future policy focus areas in Japan are 1) Implementing a green circular recovery to build back better (Post Covid-19) in a green and circular manner. The EU has proposed a distinctly green and circular recovery, and Japan is moving in the same direction. 2) Continue to enhance global political cooperation on the circular economy building on the EPA, SPA and the EU-Japan Connectivity Agreement,</p>

Country	Progress and outlook of CE
	<p>and the high-level environment dialogue, high-level economic dialogue, and bilateral industrial policy dialogue. Japan must continue to align and strengthen both the EU's and Japan's mutual interest areas through such proposals as the EU's Circular Economy Action Plan's Global Circular Economy Alliance. This also helps towards concretizing projects for third market collaboration. And 3) Increase public awareness and support of the circular economy which can be done by actively promoting circular business models and showing their commercial viability. Successful public-private partnerships like CLOMA should be encouraged for other key circular economy issues, to strengthen connections between manufactures and waste managers, and the demand for secondary resources. In the long term, more radical steps such as moving towards taxing resources rather than labor should also be considered.</p>
Singapore	<p>Trend of plastic industries (consumption/waste): The recycling rate of Plastic waste increased from 4 per cent in 2020 to 6 per cent in 2021. There was a 60 per cent increase in the amount of Plastic waste recycled with more processed locally and exported. More needs to be done to improve the recycling rate of Plastic waste as it remains low despite the increase.</p> <p>Progress of CE: Production - Requires mandatory reporting of packaging use for producers and retailers from 2022 onwards. Consumption - No legislation for consumer behaviour yet. Disposal - The Zero Waste Masterplan aims to reduce waste sent to landfill by 30% by 2030. Recycling - A deposit refund system has been announced to be implemented in 2022 and is currently undergoing industry consultations.</p> <p>Gaps CE compare with global situations: Singapore has low priority and disparities when compared with the EU on Alignment on production and source reduction standards. It would be very complex to implement in Singapore and it will take time to change the regulatory framework. Singapore is a very competitive economy so it is unlikely that the Government would put a break on the manufacturing sector easily especially for SMEs. Developing Secondary Market strategies is also another gap. While these strategies are much needed, it would be best to strengthen existing frameworks before exploring secondary markets. Singapore would need to identify global sources for recycled feedstock, given the lack of a recycling industry. Other Challenges in circularities on food packaging are listed as</p> <ul style="list-style-type: none"> • Lack of consumer demand • Scepticism of the recycling system in Singapore • Need for multi-stakeholder collaboration • Closed-loop logistics systems challenging for companies without local production sites • Incongruent policies, regulations and infrastructure internationally • Current focus on short-term profits

Country	Progress and outlook of CE
	<p>Regulations/Law: General Legislative Framework - The Resource Sustainability Act outlines three focus waste streams (including packaging) and strategies to increase collection for recycling rates for these streams.</p> <p>Lesson learns for Thai government: Singapore’s success is based a review of the EU framework which provides an expansive set of best practices, highlights potential challenges, and helps identify critical instruments that could help achieve circularity goals. It provides a rich discussion ground for policy forward economies such as Singapore that have made forays into the field of circularity. Singapore’s policy frameworks are driven by an obvious emphasis on an integrated planning approach as engaging in dynamic urban governance i.e. engaging extensively with the public, industry, and other stakeholders and alignment with its focus on resilience. The Climate Change Action Plan and the more recent Zero Waste Master Plan lay the foundations for increasing circularity in Singapore. The Zero Waste Master Plan spells out specific targets such as a 30% reduction in waste to landfill by 2035 and a 70% overall recycling rate (81% non-domestic recycling rate and a 30% domestic recycling rate). The key drivers for action in the Zero Waste Master Plan are 1) Pushing boundaries through Research and Infrastructure, 2) Transforming the environmental services industry, and 3) Co-creating solutions with the community. The Resource Sustainability Act 2019 provides legislative support to the Zero Waste Master Plan, mandating specific reduction and reporting requirements for e-waste, food waste and packaging waste. The Resource Sustainability Act introduces EPR for e-waste and packaging waste, which is a big step in terms of reorganizing financing and organizing of collection, sorting and recycling of waste.</p> <p>Outlook for future: A framework to prioritize next steps with respect to Singapore-EU collaboration in prioritizing actions to 4 groups: Quick wins, Long term Engagements, low priority, and Exploration. Quick wins are actions with the ease of adoption which strategies will build trust and create a conducive environment for longer-term engagement. Examples include Adoption of the Waste Hierarchy, Alignment on Landfill Management Principles, Innovation and Research, Adoption of GPP and strengthening of Eco Labels, and Regulation to phase-out of certain single-use plastic products. Long term engagements are strategies that will lead to high levels of circularity and already have the required framework to adapt to the Singapore context such as Segregated Waste Disposal and Collection, and Adoption of EPR and DRS System. Low Priorities are strategies that are neither easy to adopt nor likely to have a great impact in terms of circularity for Singapore, given disparities when compared with the EU such as Alignment on production and source reduction standards, Developing Secondary Market strategies, and Waste to Energy (as it is already well taken care of in Singapore and would be the least preferred option in terms of developing the Circular Economy). Explorations are strategies that may be harder to adopt/ implement but are likely to have great impact on circularity. They merit careful consideration such as Alignment on a comprehensive circular economy policy with deep focus on plastics, and Local and Regional Recycling Opportunities.</p>

Country	Progress and outlook of CE
India	<p>Trend of plastic industries (consumption/waste): Over a five-year period, the plastic consumption in India has risen at a compounded annual growth rate (CAGR) of 9.7 per cent to 14 MT in the financial year 2016-17 to 20 million tonnes in 2019-20, Marico Innovation Foundation said in a report released in the national capital.</p> <p>Progress of CE: Production- Plastics producers need to work out modalities for waste collection systems for collecting back the plastic waste within a period of six months. No targets set. Maharashtra state requires industrial packaging produced to include at least 20% recycled material.</p> <p>Consumption - Waste generators including Institutional generators, are required to segregate plastic waste.</p> <p>Disposal - Local bodies are responsible for segregation, collection, storage and disposal. No targets set. Local bodies are required to encourage use of plastic waste for road construction or energy recovery or waste to oil or co-processing in cement kilns under Plastic Waste Management Rules 2016.</p> <p>Recycling - The draft 2019 National Resource Efficiency Policy sets targets for packaging recycling including 100% recycling rate for PET by 2025 and 75% recycling and reuse rate for other plastics by 2030.</p> <p>Gaps CE compare with global situations: The packaging industry represents the largest sector for plastic use in India, accounting for 59%, present in nearly half of all packaged items. Gaps in 4 issues have been identified. 1) Effective and Sustainable Plastic Waste Management Strategies. The lack of a functioning solid waste management system is one of the critical barriers, as only one-quarter of PW is recycled in India. The impact is far more widespread, as improper disposal creates burdens on landfills and poses health-related challenges to waste pickers, who are mostly women. Despite high collection efficiency, the treatment rate is very low. The capacity building and rendering technology have not been adequately prescribed in rural areas. The development of waste management strategies and maintaining the material market value of recycled materials are critically important. 2) Restructuring Reverse Supply Chain. A feedback mechanism in terms of quality and market requirements for recycled plastics from end-user industries could help institutionalize and organize recyclers and plastic processors. For India, the primary resource recovery challenges lie within the area of socio-technical model development, transforming the informal sector to the formal economy, the establishment of material recovery facilities, support structures and institutional framework development for the population related to waste picking, and the implementation of a technology-supported knowledge management system for waste management. 3) Source-Specific Waste Recovery. Resource recovery from food packaging, considering PE, PET, PVC, and PP, should be the highest priority. Recycling and waste elimination from multilayer food packaging is one of the main challenges for the Indian PW management system. And 4) EPR- and PW-Related Rules. There is a lack of clarity regarding roles, responsibilities, and proper guidelines for producers, importers, and plastic products manufacturers. Furthermore, there is a need for real-time monitoring and clear mapping of the</p>

Country	Progress and outlook of CE
	<p>producers and associated state-wise plastic demand and supply, which might provide achievable and accountable EPR targets.</p> <p>Regulations/Law: General Legislative Framework - Plastic Waste Management (PWM Rules), 2016. Collection targets exist and minimum requirements for EPR schemes do not exist in these rules.</p> <p>Lesson learns for Thai government: India is currently facing a substantial plastic challenge. While its plastic consumption per capita remains low, its production of plastic waste in absolute terms makes it the 15th largest producer of plastic waste in the world. A substantial proportion of this waste is mismanaged with negative consequences on the natural environment and human health. While top-down policies are known to play an essential role in tackling plastic related issues, sustainability transitions literature suggest that bottom-up initiatives conducted by communities and industry can play a central role in driving sustainability transitions, by developing niche initiatives that can enter the mainstream and potentially lead to regime shifts. (Ref) In addition, there is a strong need for Improved Rural Plastic Waste Management as Most parts of rural India have no waste collection mechanism in place and as a result, the waste including plastic waste is either dumped in the outskirts of the villages or burnt periodically at household level or at the village outskirts. In India where more than 60–70% of its people reside in rural areas, improper rural waste management can pose lot of environmental and health threats. Even in states where there is plastic bag ban in place, plastic bags are still in use. Review of India situation suggest that market mechanisms’ are important elements of a circular economy which is noy yet developed in India's policy framework.</p> <p>Outlook for future: In India, the implementation of EPR is the primary task that needs to be fulfilled. In addition, flows of plastic from overseas often overburden the whole system, requiring controlled monitoring to identify the flow and quality of waste entering the country. Local councils and states that are located along coastlines require an active role in minimizing the environmental impact and leakage of plastic waste into land and marine ecosystems. The legal aspects of waste should provide a more precise and concise outlook regarding the PW supply chain’s role and responsibilities. Particular attention should be given to integrating informal recyclers into formal collection and recycling channels and implementing unique recycling technology for multiplayer plastic polymers. The baseline assessment of mismanaged single-use plastic is crucial, along with regulatory, economic, awareness, and voluntary interventions. Capacity building, infrastructural development (material recovery facilities at the micro-level in the country and the proper collection, segregation, and transportation of discarded plastic material), and financial support (incentives and innovative economic model) for chemical and biological recycling should be the priority of governments, especially in rural areas. In addition, upstream material management is critical for resource management and the circular economy, making consumer awareness and the mindset towards acceptability of recycled products equally important.</p>

Country	Progress and outlook of CE
European Union	<p>Trend of plastic industries (consumption/waste): The European plastics industry is tackling challenges on multiple fronts. In packaging, by far its biggest market, it has become a victim of its own success, particularly as the ideal material for single-use applications and people on the move. In building and construction, some infrastructure projects may go on hold as governments divert some funds away from infrastructure projects to defence, although business is being boosted as consumers get help to improve energy efficiency in their houses. In automotive, component suppliers are suffering because car makers have been cutting production – not as a reaction to reduced demand, but because they cannot obtain the chips they need for their electronics.</p> <p>Progress of CE: Production - The “essential requirements of packaging” requires the minimization of packaging volume and weight, design of packaging for reuse or recovery and the encouragement of recycled materials usage in packaging. The EU Commission is also initiating work on new harmonized rules to ensure that by 2030 all plastics packaging placed on the EU market can be reused or recycled in a cost-effective manner.</p> <p>Consumption - The Single Use Plastics directive bans selected single-use products made of plastic for which alternatives exist by 2021 and implements EPR systems for others.</p> <p>Disposal - The EU Landfill Directive aims to phase out landfilling for recyclable material by 2025.</p> <p>Recycling - The Single-Use Plastics Directive establishes EPR systems, by 2025, which covers the costs of collection, transport, treatment, cleanup of litter and awareness-raising measures for all packaging. The directive mandates: (a) new recycling target for plastic packaging, set at 55% in 2030; (b) Specifically for plastic PET bottles a 25% recycled content target by 2025 and 30% recycled content target by 2030; (c) Collection target of 77% of single-use plastic drink bottles by 2025 and 90% by 2029 through EPR or through deposit refund schemes.</p> <p>Gaps CE compare with global situations: For EU, to reach a sustainable and circular use of plastics, different stages of the value chain as well as different types of environmental and climate impacts are addressed. A combination of the three pathways: Smart use, Increased circularity, and Renewable material, offers a way forward for the longer term. However, there are gaps in such pathways. 1) Smarter use focuses on production and use to alleviate problems connected to leakage and toxicity, but it focuses less attention on the impacts on climate change and other negative externalities. 2) Increased circularity aims to integrate the entire value chain to improve the circularity of plastics. However, circular plastic economy initiatives often do not address the expanding levels of consumption or the dependence of plastics on fossil resources. And 3) Renewable material takes up the fossil lock-in of plastics but does not focus on their use and waste management. Switching to renewable materials would not in itself do much for the leakage problem of plastics.</p>

Country	Progress and outlook of CE
	<p>Regulations/Law: General Legislative Framework - The Packaging and Packaging Waste Directive sets targets for the recovery of packaging waste and covers strategies to be implemented by member states to collect packaging waste.</p> <p>Lesson learns for Thai government: The European Union’s approach to Circular Economy is evident both in the regulatory framework as well as the principles that underlie this regulatory framework. The underlying principles include: (1) Clear prioritization of waste management initiatives as evidenced by the waste hierarchy, which allows for the emphasis on treatments that are higher up on the hierarchy. For e.g. supporting recycling over waste to energy. (2) The setting of measurable targets, which allows each of Member States to develop plans to reach the required target rates such as recycling or recovery and explore the appropriate instruments (Extended Producer Responsibility, ‘EPR’, packaging fees, etc.) which will allow them to achieve the targets. And (3) Development of focused and customized approaches for each object of circularity, which allows for a more customized effort depending on the material and its circularity potential, for e.g. organic waste, waste, and electrical equipment (Waste Electronic and Electrical Equipment/ e-waste), packaging, single-use plastics.</p> <p>Outlook for future: Three pathways can lead to a more circular, sustainable plastics system: smarter use, increased circularity and renewable material. Good practice examples for each of these pathways across Europe among business, policymakers and citizens will serve as an inspiration for how to make plastics more sustainable and circular. Most good practice examples found are small scale and would need to be scaled up and implemented much more broadly to strengthen the circular plastics economy. At the moment, the pathways are not developing at the same pace. Increased circularity is the most developed, with several relatively large-scale good practice examples. Smarter use is emerging, with a growing number of good practice examples showing potential to be scaled up. Renewable material is the least developed, but many examples show high potential for further development.</p>

Chapter 7 CE product verification guideline handbook

7.1 Background and purpose

The importance of the guideline handbook for CE product verification implementation for plastics packaging in supply chains cannot be overstated, particularly for the Mekong Region countries, which are currently facing a plastic waste crisis. By providing clear guidance on how to implement CE product verification techniques, the handbook can help organizations in the plastics packaging supply chain reduce their environmental impact, promote sustainable practices, and contribute to a circular economy. This is particularly important given the negative impacts of plastic waste on the environment, human health, and the economy.

The handbook can also help to standardize CE product verification practices across the region, promoting a more consistent and effective approach to circular economy implementation. This can, in turn, help to address the plastic waste crisis in the Mekong Region and contribute to the global effort to promote sustainable development.

7.2 Importance of a circular economy approach to reduce plastic waste

In a linear economy, products are manufactured, used, and then discarded as waste, resulting in a significant amount of plastic waste being generated. This waste often ends up in landfills or in the natural environment, where it can take hundreds of years to decompose and have negative impacts on wildlife, water quality, and human health. In contrast, a circular economy approach aims to keep resources in use for as long as possible, through strategies such as reuse, repair, and recycling. This approach can help to reduce the amount of plastic waste generated by the plastics packaging industry, while also conserving natural resources and reducing greenhouse gas emissions. In a circular economy, plastic waste is not seen as a problem but as a valuable resource that can be reused and recycled. A circular economy approach can provide economic benefits by reducing the reliance on virgin materials and creating new markets for recycled plastics. This can help to reduce the environmental impact of plastic production and consumption, while also contributing to economic growth and development. By 2040, a circular economy has the potential to reduce the annual volume of plastics entering our oceans by 80%, reduce greenhouse gas emissions by 25%, generate savings of USD 200 billion per year, and create 700,000 net additional jobs.

7.3 Overview of the plastics packaging supply chain and the need for CE product verification

The plastics packaging supply chain is a complex network of organizations and processes involved in the design, production, distribution, use, and disposal of plastic packaging materials. This supply chain includes various stakeholders such as plastic manufacturers, packaging

converters, brand owners, retailers, consumers, waste management companies, and recyclers. The need for CE product verification in the plastics packaging supply chain arises from the significant negative impact of plastic waste on the environment, human health, and the economy. A large amount of plastic waste ends up in landfills, oceans, and other natural environments, where it can take hundreds of years to decompose, harming wildlife and ecosystems, and creating health hazards for humans. To address this issue, it is important to promote a circular economy approach in the plastics packaging supply chain. CE product verification is a critical component of this approach, as it involves the identification and verification of products that have been designed, produced, and used in a way that promotes circularity.

Several types of plastic packaging are commonly used in supply chains. Some of the most common types include: Polyethylene Terephthalate (PET), Polyvinyl Chloride (PVC), Polypropylene (PP), Polystyrene (PS), and High-Density Polyethylene (HDPE). These are just some examples of the different types of plastic packaging used in supply chains. Each type has its own properties and typical applications. Plastic packaging is used in a wide range of industries and products, including food packaging, appliances, smartphones, car parts, exercise equipment, and roller skates. However, only around 15% of the total plastic produced is recycled today, and about 11 million metric tons of plastic leak into the ocean annually. The concept of circular plastic packaging in supply chains refers to the idea of transitioning towards a more sustainable and circular use of plastic packaging. This involves prioritizing resources and capabilities along the supply chain to reduce waste and increase the use of recycled materials.

Open-loop recycling of plastic refers to a recycling process where plastic materials are converted into both new raw materials and waste products. A common example of open-loop recycling of plastic is when plastic bottles are recycled into sleeping bags or fleece jackets. Open-loop recycling processes usually involve processing various types of products of similar material makeup and change the properties of the material itself (through heat, chemical reactions, or physical crushing) and is often associated with a degradation of the material being recycled, and a loss of attached materials that are not being recycled. Open-loop recycling is also referred to as down cycling or reprocessing.

CE product verification helps to ensure that plastic products are designed for circularity, that they are produced using sustainable and eco-friendly processes, and that they are used in a way that reduces their environmental impact. Verification provides a means to measure and track progress towards circularity and sustainability goals, which can help to drive continuous improvement and innovation in the supply chain. The CE mark is probably the most widely used and recognized marking required by the European Union for product verification. It is primarily recognized within the European Union and European Economic Area. However, many countries outside of the EU have similar regulatory requirements and may accept products with a CE mark as meeting their own standards.

Overall, the plastics packaging supply chain plays a crucial role in the global effort to address the plastic waste crisis. By promoting a circular economy approach and implementing CE

product verification techniques, the supply chain can reduce its environmental impact, promote sustainable practices, and contribute to a more sustainable and resilient future

Chapter 8 CE product verification techniques

CE product verification is an essential process for ensuring that products meet specific requirements, including quality, safety, and environmental standards. The use of CE product verification techniques in the supply chain has become increasingly important in recent years due to the growing demand for sustainable and environmentally friendly products. There are various CE product verification techniques that can be used in the supply chain, including the use of certification schemes and product labeling. An overview of the different CE product verification techniques that can be used in the supply chain, including certification schemes, product labeling, and other verification methods is summarized as follows.

8.1 Techniques

CE product verification techniques are a set of methods used to ensure that products meet the criteria for circularity and sustainability. These techniques include Life cycle assessment (LCA), Material traceability, Eco-design, Certification schemes, Upcycling and recycling, Closed-loop supply chains, Product labeling, Product standards, Waste-to-energy, and Extended producer responsibility (EPR). Overall, there are many different CE product verification techniques that can be used to promote sustainability and circularity in the plastics packaging supply chain. Organizations can choose the techniques that are most relevant to their products and supply chains to ensure that they are operating in a more sustainable and circular manner. By implementing these CE product verification techniques, organizations can ensure that their products meet the criteria for circularity and sustainability, and contribute to a more sustainable future.

8.2 Upcycling

Upcycling, also known as creative reuse, is the process of transforming by-products, waste materials, useless, or unwanted products into new materials or products perceived to be of greater quality, such as artistic value or environmental value. The methodology for upcycling varies depending on the materials being used and the desired end product. However, the general principle involves assessing the potential of waste materials and finding creative ways to repurpose them into something new and valuable. This can involve disassembling and reassembling materials, combining different materials together, or simply finding a new use for an existing item. The upcycling process typically involves transforming plastic waste into a new material, such as a composite material or a 3D printing filament, or into a new product, such as a piece of furniture or a fashion accessory. This is done by combining the waste plastic with other materials or by using specialized techniques to reshape and reform the plastic into a new form. The theory of upcycling plastic is based on the principles of the circular economy, which seeks to minimize waste and maximize the use of resources by creating closed-loop systems in which waste materials are reused and repurposed. By upcycling plastic waste, organizations can reduce their environmental impact, conserve resources, and create new business opportunities.

8.3 Return-to-refill

The theory and principles of Return-to-Refill are based on the circular economy concept, which aims to keep resources in use for as long as possible and minimize waste. The key principle of Return-to-Refill is the reuse of materials and containers, which involves Designing durable and reusable containers, Establishing a closed-loop system, Reducing the environmental impact, Promoting a sustainable business model, Extended Producer Responsibility (EPR), Cradle-to-Cradle (C2C) Design, Sharing Economy, and Product as a Service (PaaS). The principles of Return-to-Refill aim to promote a circular economy, reduce waste, and encourage businesses to adopt more sustainable practices.

8.4 Reuse

Reuse is the practice of using an item more than once, extending its lifespan and reducing waste. The theory of reuse can be approached from different perspectives, including economic and environmental. From an economic perspective, an economic model of reuse has been developed to analyze the effect of reuse activity on the amount of waste in the economy and the welfare of consumers. From an environmental perspective, reuse is an important component of waste reduction and resource conservation. By reusing items instead of discarding them, we can reduce the amount of waste that ends up in landfills and reduce our consumption of new resources.

The theory of Reuse is based on the idea that products and materials can be used multiple times before they are disposed of, thus reducing waste and conserving resources. The principles of Reuse include Durability, Modularity, Standardization, Compatibility, Reverse logistics, and User behavior. By applying these principles, products can be designed, manufactured, and used in a way that maximizes their reuse potential, reducing waste and conserving resources. Additionally, successful reuse systems can provide economic and environmental benefits by creating new markets for reusable components and reducing the need for virgin materials.

8.5 Examples of products that can be verified using these techniques

Here are some other examples of products that can be verified using the techniques mentioned:

- **Biodegradability:** A manufacturer can develop biodegradable plastic packaging and verify the biodegradability rate and safety of the end-product.
- **Recycling:** A recycling facility can verify the percentage of recycled content in their plastic pellets and ensure that they meet certain quality standards for use in new products.
- **Repurposing:** A furniture manufacturer can repurpose discarded plastic materials, such as plastic bags, into new furniture products, such as chairs or tables. The verification can ensure that the repurposed material meets certain quality and safety standards.

Chapter 9 CE standards and certifications

CE product verification is an important aspect of ensuring that products meet certain sustainability standards throughout their life cycle. To achieve this, various standards and certifications have been developed that aim to address environmental, social, and economic impacts of products. The implementation of CE product verification in the supply chain requires careful planning and consideration of relevant standards and certifications. An overview of the various standards and certifications related to CE product verification and their relevance in the supply chain is summarized as follows.

9.1 ISCC Plus

The ISCC (International Sustainability and Carbon Certification) standard is relevant for CE (Circular Economy) product verification, particularly in the case of plastic waste material. ISCC provides a system for certifying sustainable biomass and bioenergy supply chains, which includes plastic waste as a feedstock. By certifying the entire supply chain from feedstock to end product, ISCC ensures traceability and transparency, making it a useful tool for CE product verification. Additionally, the ISCC standard addresses environmental and social sustainability issues, which are critical aspects of CE. ISCC supports recycling and the development of the circular economy with its certification approach. The ISCC PLUS standard covers all types of waste and residues, including plastic waste material. Both pre- and post-consumer waste are covered.

The mass balance approach is a method used to trace the flow of materials through a complex value chain. It is based on verifiable bookkeeping and allows for the tracking of the amount and sustainability characteristics of circular and/or bio-based content in the value chain. This approach makes it possible to gradually increase the share of bio-based and/or circular feedstocks in the production process. In addition, the calculated share of bio-based and/or circular feedstocks can be attributed on an equivalent basis to one or several outputs. On this basis, the ISCC PLUS mass balance approach allows system users to make credible claims.

9.2 ISO/IEC 17029

Designing a verification and validation scheme for CE product verification implementation for plastics packaging in supply chains as per standard requirement of ISO/IEC 17029 involves the following steps as shown in Figure 9a.

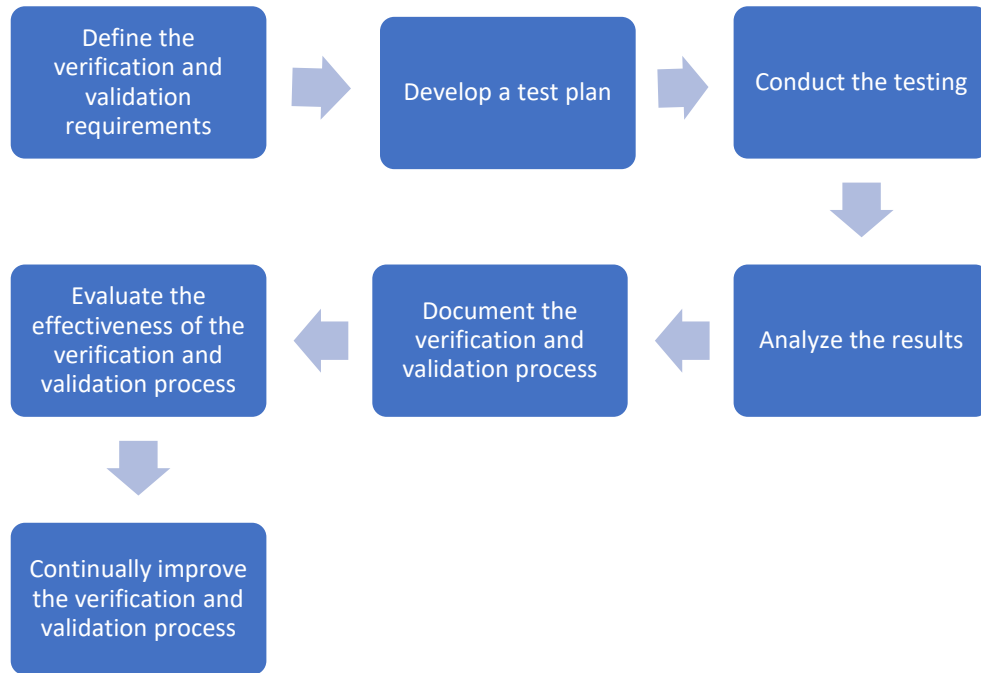


Figure 9a General steps in Designing a verification and validation scheme for CE product verification implementation for plastics packaging in supply chains as per standard requirement of ISO/IEC 17029

By following these steps, a comprehensive verification and validation scheme can be developed and implemented for CE product verification implementation for plastics packaging in supply chains as per the standard requirements of ISO/IEC 17029. On the other hand, the seven steps in Figure 9a could be shortened into five steps in Figure 9b. By following these steps, a comprehensive verification and validation scheme for CE product verification implementation for plastics packaging in supply chains as per standard requirement of ISO/IEC 17029 can be designed and implemented.

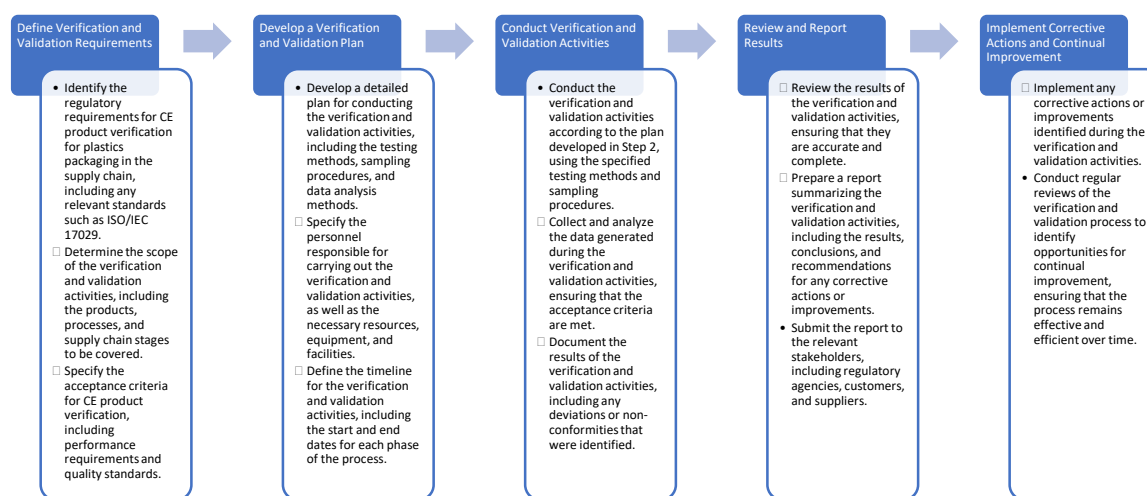


Figure 9b Steps in Designing a verification and validation scheme for CE product verification implementation for plastics packaging in supply chains as per standard requirement of ISO/IEC 17029

9.3 Cradle to Cradle Certification

The Cradle to Cradle Products Innovation Institute is a non-profit organization that is dedicated to powering the circular economy through products that have a positive impact on people and planet. Through the Cradle to Cradle Certified® Products Program, the Institute sets the global standard for products that are safe, circular and responsibly made.

9.4 EU Ecolabel

The EU Ecolabel is a voluntary labeling scheme that promotes environmental excellence by certifying products that have a reduced environmental impact throughout their life cycle. The criteria for the EU Ecolabel include requirements for raw material extraction, manufacturing, packaging, and disposal, as well as limits on the use of hazardous substances. In the context of CE product verification, the EU Ecolabel can be relevant for plastic waste material as it sets standards for sustainable production and consumption. It is important to ensure that the recycled material is produced in an environmentally sound manner. By meeting the EU Ecolabel criteria, products made from recycled plastic can demonstrate their environmental performance and contribute to the transition to a more sustainable economy.

The EU Ecolabel criteria are a set of environmental and performance requirements that a product must meet in order to be certified with the EU Ecolabel. The criteria cover a range of

categories such as energy efficiency, water conservation, waste reduction, and hazardous substances. For plastic waste materials, the criteria may include requirements related to the use of recycled content, the reduction of hazardous substances, and the promotion of sustainable production and consumption practices.

9.5 Standard and certification and how they relate to CE product verification for plastics packaging

ISO 14001: This standard specifies the requirements for an environmental management system (EMS) that a company can use to enhance its environmental performance. The ISO 14001 standard can be used by companies in the plastics packaging industry to identify and manage their environmental impacts, including waste management, energy efficiency, and reduction of greenhouse gas emissions.

Forest Stewardship Council (FSC): The FSC is an international certification system for forests and forest products. This certification ensures that the products come from responsibly managed forests that provide environmental, social, and economic benefits. FSC certification is relevant to CE product verification for plastics packaging because many companies use paper-based packaging materials that require responsible sourcing.

Sustainable Forestry Initiative (SFI): This certification program ensures that the products come from forests that are managed sustainably, considering social, economic, and environmental factors. The SFI certification is relevant to CE product verification for plastics packaging because many companies use paper-based packaging materials that require responsible sourcing.

Global Recycled Standard (GRS): This is a voluntary product standard for tracking and verifying the content of recycled materials in a product. The GRS evaluates products based on input material, traceability, environmental practices, social requirements, and chemical restrictions. GRS can be relevant for CE product verification for plastics packaging as it ensures that the recycled materials used in the packaging meet environmental and social standards.

Carbon Trust Certification: This certification verifies the carbon footprint of products, services, and organizations. It can be relevant for CE product verification for plastics packaging as it can help organizations reduce their greenhouse gas emissions, which can include measures such as using more sustainable materials or reducing waste.

Chapter 10 Implementing CE product verification in the supply chain

Implementing CE product verification in the supply chain can be a challenging task, especially when it comes to ensuring the environmental sustainability of plastic packaging. It requires a thorough understanding of the relevant standards and certifications that can guide the implementation process. An overview of the relevant standards and certifications related to CE product verification for plastics packaging are summarized. The implementation process and the steps required to ensure compliance with these standards were also presented.

10.1 Step-by-step guide for implementing CE product verification in the supply chain

ISO 17029 provides a globally recognized standard for the accreditation of conformity assessment bodies that perform product certification. By following ISO 17029, companies can ensure that their CE product verification process is reliable, consistent, and meets international standards. The standard provides a framework for the design and implementation of conformity assessment schemes, including requirements for validation and verification methodologies, traceability, and risk management. Adhering to ISO 17029 can also increase confidence and trust in the products and services of a company, which can ultimately lead to improved market access and competitiveness. Step-by-step guide for implementing CE product verification in the supply chain is shown in Figure 10a.

Basic Data	• Collect data on the types of plastics used in the supply chain, their sources, quantities, and destinations
Management System	• Implement a management system to manage the CE product verification process, including roles and responsibilities, procedures, and documentation
Traceability	• Establish a traceability system to track the flow of plastic waste and recycled material throughout the supply chain. This includes documentation of the origin and composition of the plastic waste, as well as the processes used for recycling and manufacturing
Mass Balance	• Implement a mass balance system to ensure that the amount of recycled material used in the production of plastic packaging is accurately accounted for
Physical Segregation	• Establish a physical segregation system to ensure that recycled plastic is kept separate from non-recycled plastic throughout the supply chain
Greenhouse Gas Emissions	• Establish a system for measuring and reporting greenhouse gas emissions associated with the production and transportation of plastic packaging
List of Best Practices	• Develop a list of best practices for implementing CE product verification in the supply chain, including guidelines for selecting suppliers, verifying compliance, and managing nonconformities
Nonconformities	• Establish a system for identifying and managing nonconformities related to CE product verification in the supply chain
Measures	• Establish measures for monitoring and evaluating the effectiveness of the CE product verification process in the supply chain

Figure 10a Step-by-step guide for implementing CE product verification in the supply chain

10.2 Identifying products suitable for verification

The activities for identifying products suitable for verification are presented in Figure 10b. These activities can help companies identify which products are suitable for verification and ensure that they are focusing their resources on the most critical products within their supply chain.

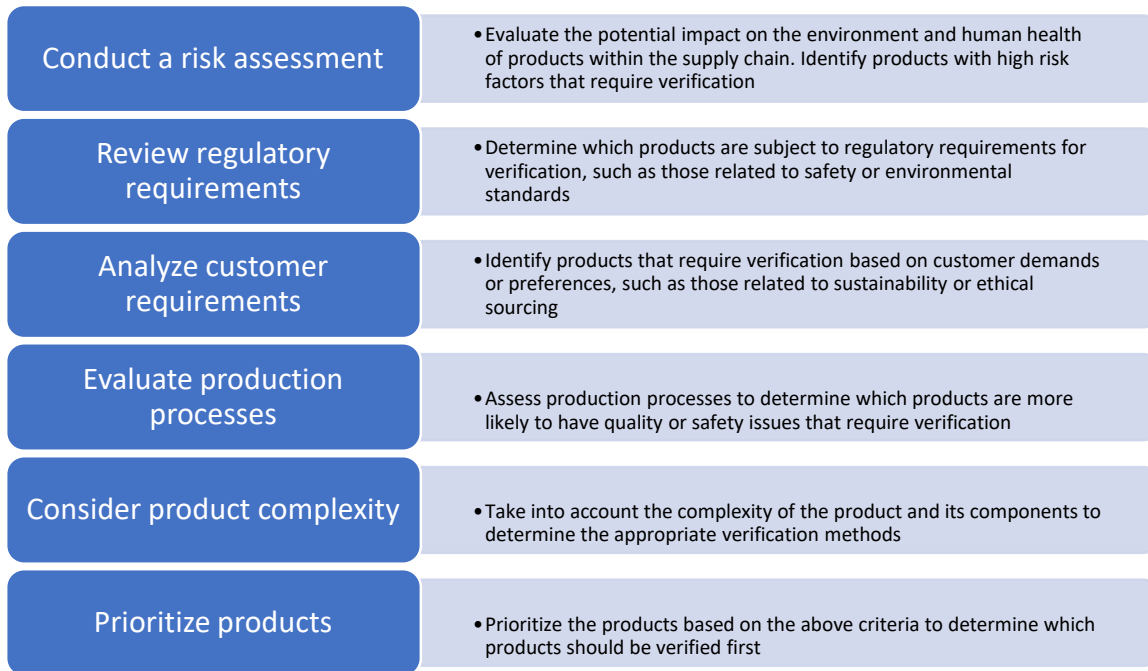


Figure 10b Step-by-step activities for identifying products suitable for verification

10.3 Selecting the appropriate verification techniques

Possible activities for selecting the appropriate verification techniques are summarized in Figure 10c. By following these activities, organizations can ensure that the appropriate verification techniques are selected for each product, and that the verification process is effective and efficient.

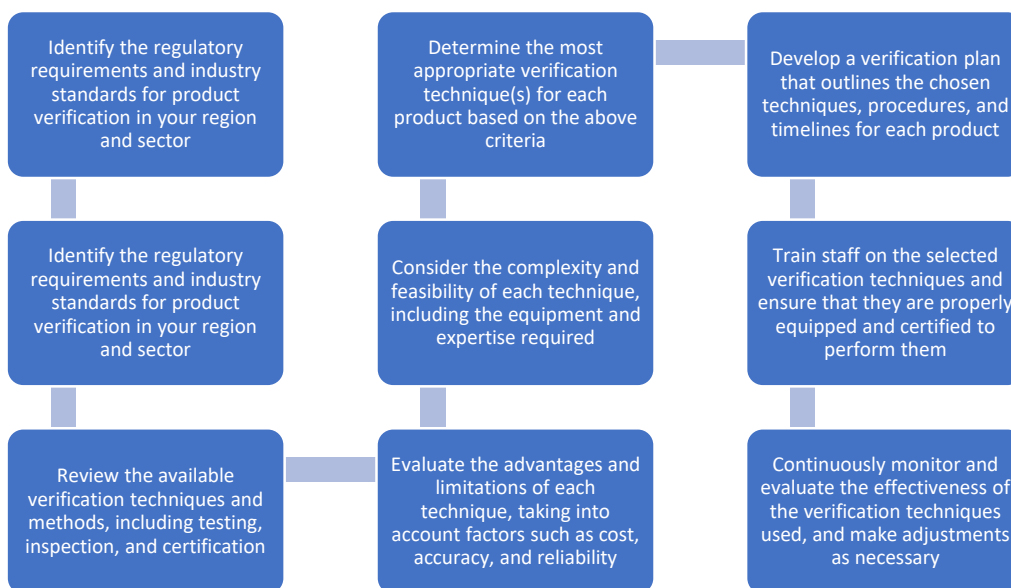


Figure 10c Activities for selecting the appropriate verification techniques

10.4 Integrating verification into existing processes

Integrating verification into existing processes can involve several activities as summarized in Figure 10d.

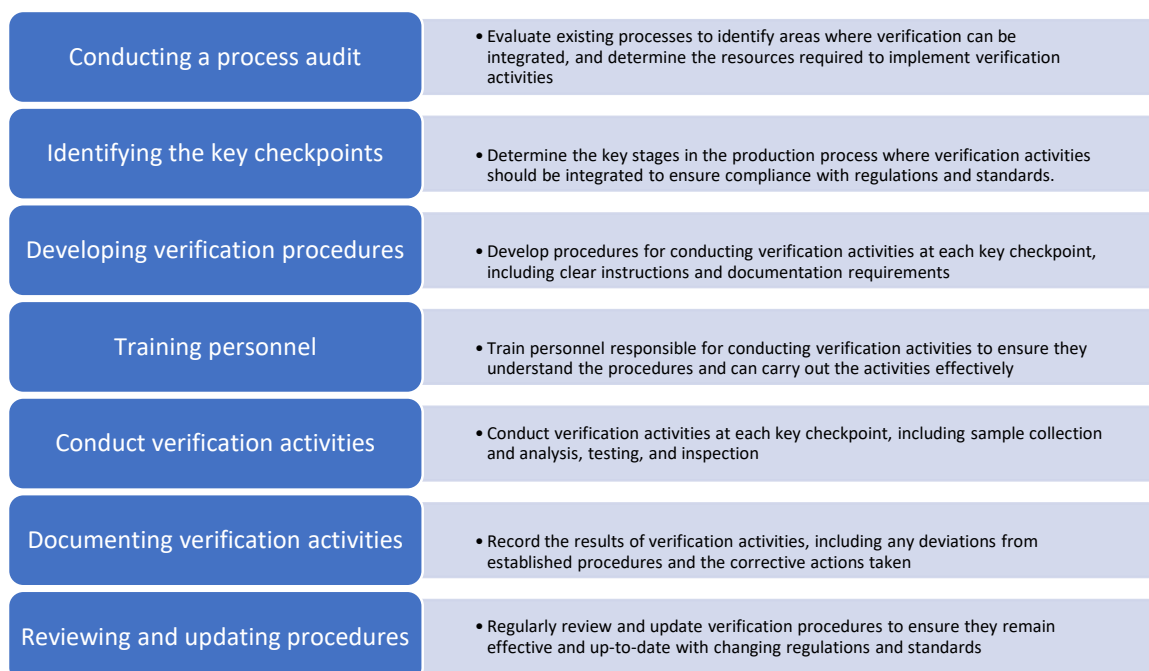


Figure 10d Activities for Integrating verification into existing processes

10.5 Making Use of the Developed Project Standard

To implement the standard developed for the project, it is important to follow the guidelines and requirements outlined in the standard. The first step is to familiarize oneself with the standard and understand its purpose and scope. The next step is to identify the relevant stakeholders and communicate the requirements of the standard to them. It is important to establish a system for tracking and verifying the source of materials used in the production of the product, as well as the production process itself. This may involve implementing a traceability system, conducting regular audits, and ensuring compliance with relevant regulations and standards. Finally, it is important to establish a mechanism for verifying compliance with the standard and maintaining records of this compliance. This may involve third-party certification, internal audits, or other methods of verification. By implementing these steps, organizations can ensure that the standard is effectively implemented and that CE product verification is conducted in a transparent and reliable manner, promoting greater trust and confidence in the products being produced and sold in the region.

Chapter 11 Monitoring and evaluation

Monitoring and evaluation are critical components of ensuring the effectiveness and success of CE product verification in the supply chain. Through proper monitoring and evaluation, organizations can identify gaps, track progress, and make informed decisions to improve their product verification processes. The monitoring and evaluation process involves collecting and analyzing data on various aspects of the product verification process, including compliance with standards and certifications, the effectiveness of product testing methods, and the overall impact on the environment. This data can then be used to identify areas for improvement and develop strategies to address them. The importance of monitoring and evaluation in CE product verification in the supply chain and some of the key tools and techniques that can be used to achieve these goals are highlighted.

11.1 Importance of monitoring and evaluating CE product verification implementation in the supply chain

Monitoring and evaluating the implementation of CE product verification in the supply chain is of utmost importance. It is a crucial step that helps ensure that the CE product verification system is functioning as intended, and it is achieving its desired outcomes. Figure 11a shows some of the key reasons why monitoring and evaluating CE product verification implementation is essential.

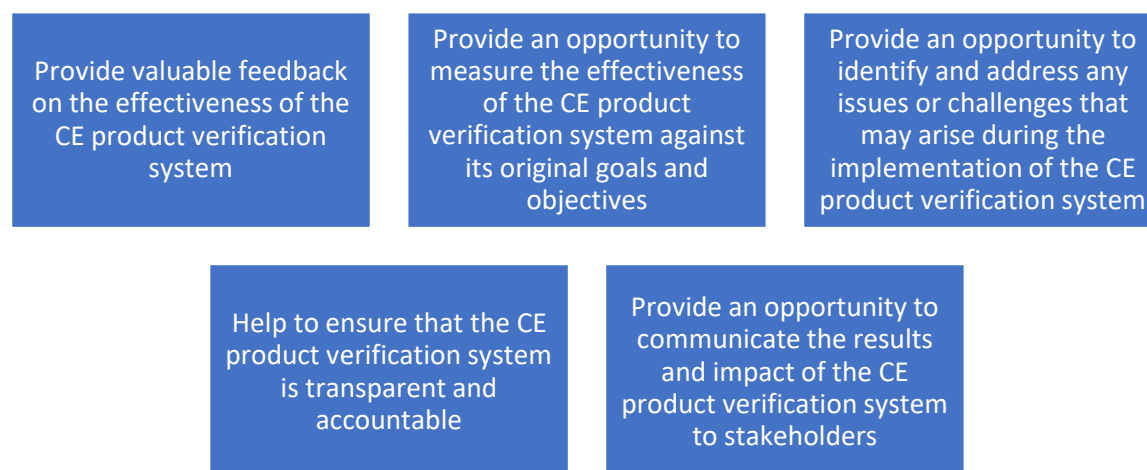


Figure 11a Key reasons highlight the importance of monitoring and evaluating CE product verification implementation

Monitoring and evaluating CE product verification implementation in the supply chain provide valuable feedback on the effectiveness of the system, measures its impact against its original goals and objectives, identifies and addresses issues and challenges, ensures transparency and accountability, and communicates results and impact to stakeholders.

11.2 Guidance on measuring and tracking progress

Monitoring and evaluating the implementation of CE product verification in the supply chain is crucial to ensure its effectiveness and to identify areas for improvement. By measuring and tracking progress, companies can identify successes and challenges, make necessary adjustments, and ensure that the program is meeting its intended goals. There are several key steps to measuring and tracking progress of CE product verification implementation as shown in Figure 11b.

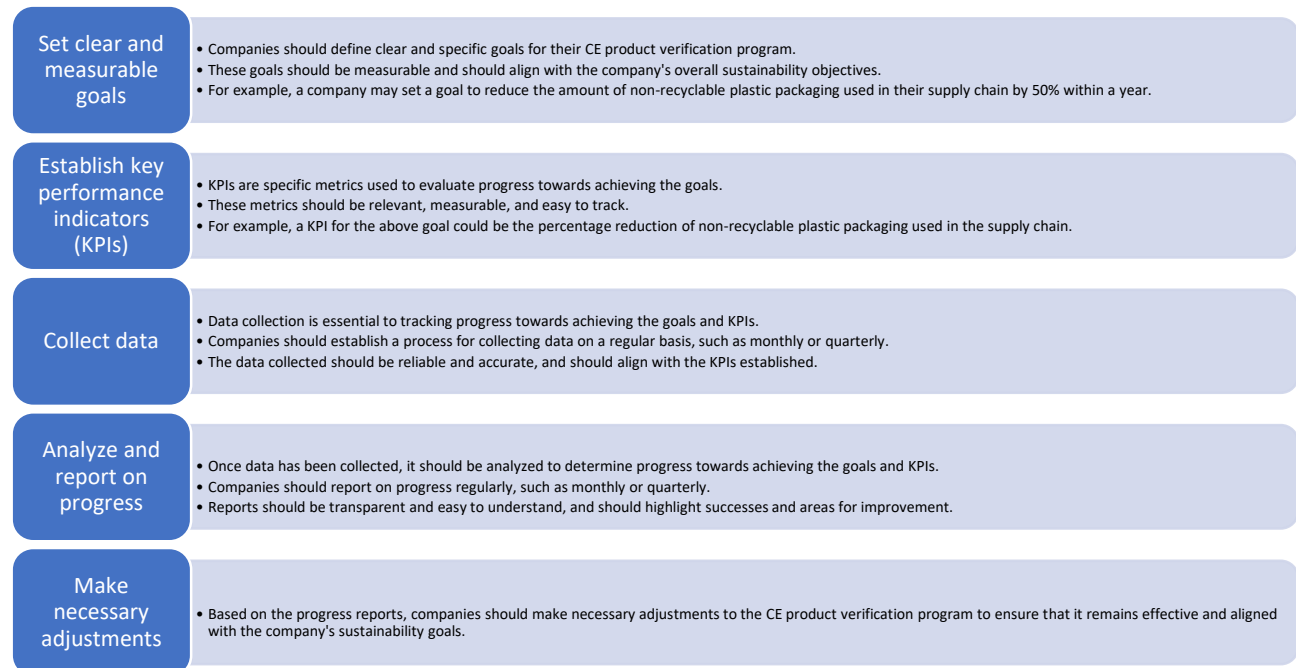


Figure 11b Key steps to measuring and tracking progress of CE product verification implementation

Companies can effectively measure and track progress towards achieving their CE product verification goals and ensure that the program is effective and aligned with their overall sustainability objectives.

11.3 Making adjustments as necessary

Implementing CE product verification in the supply chain is a continuous process that requires ongoing monitoring and evaluation. This means that adjustments and improvements must be made as necessary to ensure the effectiveness and success of the verification program. The important aspects of making adjustments are presented in Figure 11c. In summary, making adjustments as necessary is a crucial aspect of implementing CE product verification in the supply chain. By regularly reviewing performance, staying up-to-date with regulations and best practices, and communicating changes effectively, the verification system can be improved and adapted to ensure its ongoing success.



Figure 11c Important aspect of making adjustments

Chapter 12 Case studies and examples of CE product verification

Implementing CE product verification in the supply chain is becoming increasingly important for companies to ensure they meet sustainability goals and customer demands. The process involves selecting standards and certifications, implementing techniques, monitoring and evaluating progress, and making adjustments as necessary. One useful way to understand the process is through case studies and examples. Some case studies and examples of CE product verification in the supply chain to provide insight into successful implementation strategies are presented.

12.1 Examples of organizations that have successfully implemented CE product verification for plastics packaging in their supply chains

Inclusion of case studies and examples from companies or organizations that have successfully implemented circular economy principles in their supply chains could provide real-world context and practical guidance for readers. CIRC-PACK is a research project funded by the European Union under the Horizon 2020 program. The project aims to develop more sustainable and efficient plastic packaging for the food and beverage industry by adopting circular economy principles. The project focuses on improving the design of packaging to facilitate its reuse, recycling, and upcycling, as well as developing new materials and technologies for the production of circular packaging. The CIRC-PACK project also includes research on the environmental impact of plastics packaging and the potential for reuse and recycling in various supply chains. The CIRC-PACK project involves a consortium of 22 partners from across Europe, including universities, research institutions, and companies involved in the packaging industry. There are several companies involved in the packaging industry that are part of the CIRC-PACK project consortium. The ultimate goal of the CIRC-PACK project is to help the packaging industry transition to a more sustainable, circular economy by providing new and innovative solutions for plastics packaging. The CIRC-PACK project aims at creating a more sustainable, efficient, competitive, integrated and interconnected plastic packaging value chain with less dependence on fossil fuels. The project is working on developing, testing and validating better system-wide economic and environmental outcomes by decoupling the chain from fossil feedstocks.

12.2 Case studies highlighting the benefits of CE product verification for plastics packaging

There are many companies and organizations that have successfully implemented circular economy principles in their supply chains. Some examples are presented in Table 12a.

Table 12a Companies and organizations that have successfully implemented circular economy principles in their supply chains.

Company	Action
IKEA	started a buy-back scheme, allowing old furniture to have a new lease of life
Adidas	developed a shoe made from sustainable materials such as coconut husk and sugar cane, and even recycled plastic bottles
Burger King	embraced the circular economy by investing in it
Coca-Cola	launched a sustainable packaging campaign, pledging to recover 75% of their bottles and cans by 2020; and implemented a tracking and monitoring system
Patagonia	implemented a product verification system called the Footprint Chronicles, which tracks the environmental and social impact of their products throughout the supply chain; also use third-party certifications such as Fair Trade Certified and Bluesign
Dell	implemented a closed-loop recycling system, which allows the company to use recycled plastic from their own products to create new products; also developed a tracking and monitoring system that allows the company to trace the recycled plastic back to its source and ensure it meets their sustainability standards.
Nike	implemented a sustainable materials index, which assesses the environmental impact of their materials and helps them select more sustainable options; also used third-party certifications such as the Better Cotton Initiative and the Leather Working Group
Unilever	implemented a Sustainable Living Plan, which includes a goal of sourcing 100% of their agricultural raw materials sustainably; also use third-party certifications such as the Roundtable on Sustainable Palm Oil and the Rainforest Alliance to ensure the sustainability of their raw materials

These case studies and examples demonstrate the importance of implementing CE product verification in the supply chain and provide valuable insight into successful implementation strategies. Companies can learn from these examples and tailor their own implementation plans to meet their specific sustainability goals and customer demands. By selecting the appropriate standards and certifications, implementing effective techniques, monitoring and evaluating progress, and making adjustments as necessary, companies can achieve their sustainability goals and contribute to a more sustainable future.

Chapter 13 Best practice in circular economy product and in waste management

13.1 Best practice in circular economy product case studies for plastic packaging in Thailand and other countries: value chain of plastic packaging waste management

The management of plastic waste in Thailand begins with household waste management. Most household waste is sent to collection points in different locations, depending on the residential situation. This collection typically occurs during the early morning or late evening each day. Once the waste is collected and prepared for pickup, it is often sorted again to separate valuable and recyclable materials. These recyclables are then sold to scrap shops. Those involved in this sorting process are often janitors responsible for maintaining the premises or dedicated waste sorters who oversee recycling at various waste collection points in condominiums, villages, or offices. When the staff come to pick up the garbage from the garbage collection point, most of the garbage is sorted again at the garbage truck of the garbage collector. Once the garbage is sorted by the garbage truck staff, the remaining waste is loaded into the truck and compressed for further loading and unloading at a central garbage collection station where garbage will be properly managed such as being sent to a landfill.

The plastic waste sorted in the first round is collected and sold to small and medium-sized sorting hubs or garbage buyers. In most cases, the prices paid by the sorting hubs are higher than the prices paid at the pick-up garbage collection points because the sorting hubs do not have to bear the cost of transportation. The sorting hub will conduct a more thorough sorting to increase the value of plastic waste, such as separating caps and labels from plastic bottles. After sorting, most sorting hubs load it in pickup trucks and sell it to plastic mills and recycling plants.

At the plastic recycling factory, the plastic waste must undergo random sample assessment to determine its quality. The factors that affect the quality of plastic waste include moisture content and cleanliness of the plastic waste. Plastic waste that fetches a higher purchase price is generally plastic waste with minimal contamination and no odor.

13.2 Best Practice of Plastic Packaging Waste Management in the Community

The Chain of plastic packaging waste started with sorting at source, sorting at drop point, sorting hub, recycle plastic waste, and brand owner.

Sorting at Source: At present, to solve the problem of plastic packaging waste, it is necessary to start managing it at the source which generally means at the household or community level. It starts by separating dry plastic packaging waste from other wet waste. Plastic trays, food bags, plastic cups, etc. The process should include separate plastic packaging waste from organic or wet waste, wash and dry the contaminated plastic wastes thoroughly before collection to reduce mold and unpleasant odors, and separate plastic packaging waste by type of plastic packaging.

- Good communication and cooperation amongst waste producers at the source (residents of condominiums, shops, offices) in separating general waste, recyclables, and wet waste from the source.
- Available smart kiosks for recycling storage which makes it more convenient for people to sort recyclables and creates more incentives for people to separate waste.
- Having a safe and comprehensive waste transportation system.
- Recording the source of garbage through QR codes nowadays is very important so that we know the source of recyclable waste.
- The presence of a sorting belt that separates the types of recyclable waste with separate sorting belts for plastic, foam, and paper.
- The installation of a garbage compactor that is directly connected to the belt of each type of recyclable, reducing the transportation process from one waste collection point to another waste collection point.
- Zoning which places each type of waste in separate locations.
- Storing raw materials indoors makes it possible to control odor problems.

The best practice example of Sorting Hub is from LoveRe Sorting Hub, People's Republic of China. LoveRe is a private company that has acquired the right to bid for waste management in Putong province. For waste storage, recyclable and dry waste storage is handled by automated waste receivers. For the waste collection by truck, waste sorted from residents or shops is sorted at drop points prepared at each location. Trucks from the waste collection company pick up and load the waste into the company's sacks. After that, they record the source of the waste and make a QR code sticker that is attached to each sack. Once the sacks of recyclable waste are filled up, they are delivered to the company's sorting center. When the truck arrives at the sorting center, the sacks containing recyclables are scanned to collect data from where they came from, weighed, and other data is recorded. After that, the recyclable waste is removed from the sacks and loaded onto a conveyor belt. It is then processed through a Manual Sorting Point where there are 6-8 full-time employees sorting recyclables as the process is shown in Figure 13a.

Waste Management Process in Sorting Hub

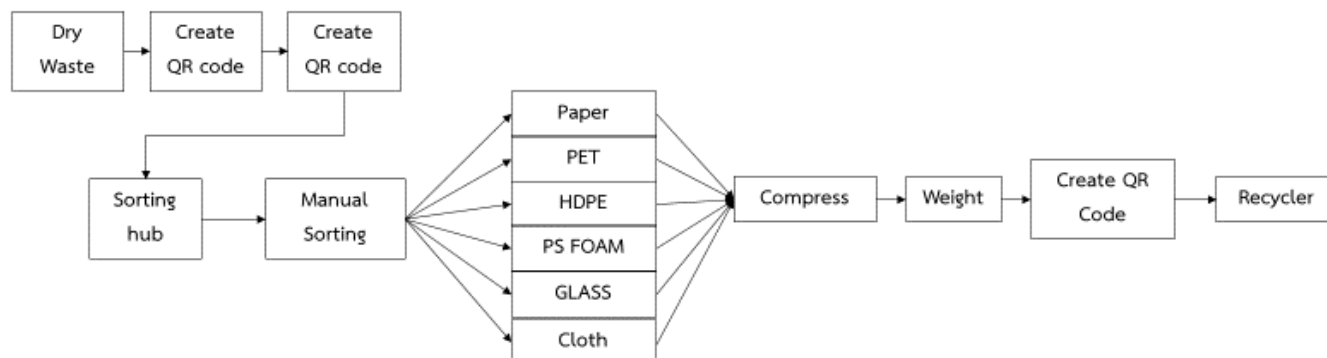


Figure 13a Work Flow at LoveRe Smart Bin

Another Example of Sorting Hub is Baiyangwan Sorting Center, People's Republic of China. Baiyangwan Sorting Center is a government-owned waste sorting station. At this station, recyclables are only accepted from the surrounding communities, shops, and offices. Baiyangwan Sorting Center's garbage pickup is commonly done by large trucks and smaller three-wheeled motorcycles with onboard storage that collect recyclables at the drop points. Drop points are defined by each community. In addition, people can also bring recycled waste directly to sell at Baiyangwan Sorting Center.

Baiyangwan Sorting Center's waste management process starts with vehicles carrying recyclable waste going through the weighing gate at the factory entrance. After the incoming weight is recorded, the recycling truck must be driven to unload the recyclable waste at the bulk yard of the sorting station. The officer then inspects the waste. Once all the recyclables have been removed from the vehicle, the unloaded vehicle is weighed again at the scale so it can then be paid for the recyclables by the staff that were purchased by the center. After the recyclables are piled up in the factory's dump yard, the staff sorts out the basic waste types such as paper, plastic, and foam. Each type of recyclable waste is then taken to its belt through loading with trolleys or using forklifts. Plastic waste is sorted and stored in a stack in the warehouse area. Foam plastic waste is collected at a foam drop point, melted in a foam crusher, and rolled out into square bales for easy collection and transportation to recycling plants (Figure 13b). Paper recycling management starts with collecting waste paper in the hopper for loading paper onto the conveyor belt. It is pulled up along the belt where it is sorted by different types of paper, such as crate paper, white paper, and color composite paper.

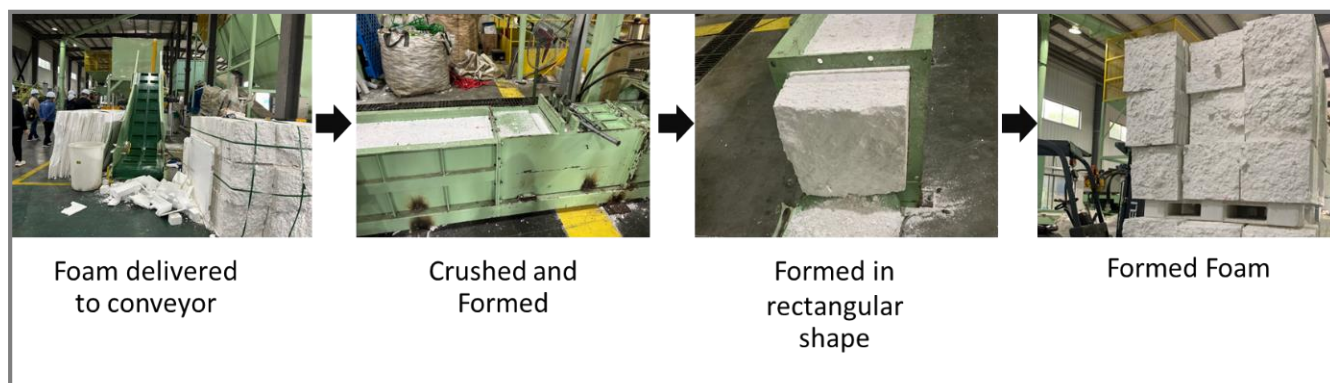


Figure 13b Foam Plastic Waste Management Process at Baiyangwan Sorting Center

Recycler: Recycling plants are a very important part of reprocessing plastic packaging waste so that plastic packaging waste can be reused again in the form of recycled plastic pellets. Having a process to manage plastic packaging waste at the source reduces contamination. Separating the types of plastic packaging waste will further improve the efficiency of recycling plant production of plastic pellets.

The plant recycler success factors depend on

- Encouraging separation at waste origin with communities results in good quality plastics, income distribution, and sustainability.
- Quality control of incoming plastic packaging waste improves the quality of pellet production and makes for more efficient recycling
- Modern production technology makes it possible to produce recycled plastic pellets in large quantities.
- For example, the use of Solid State Polymerization (SSP) technology enables the production of recycled plastic pellets that have been certified as food contact grade by the Food and Drug Administration of Thailand, allowing them to increase the value of recycled plastic pellets.
- Having a closed raw material storage warehouse to be able to sell the waste at a good price as the price of plastic packaging waste sometimes fluctuates. A covered warehouse to store raw materials will reduce the damage to raw materials such as by moisture from rain, soil contamination, and dust.

The example of successful recycler is ENVICCO LIMITED, Thailand. ENVICCO LIMITED is a recycling plant in Thailand that produces food contact grade recycled plastic pellets approved by the Food and Drug Administration of Thailand (PET Recycled Plastic Pellets). PET has been used mainly by consumers or Post Consumer Recycle to produce recycled plastic pellets that can be reused into PET plastic bottles with the production process. There is a process to check the quality of waste before it enters the production line, including waste received from vendors with clear verification of the origin of the waste and waste bought from surrounding communities with

clean waste separation. As a result, the quality of the factory's rPET resin has been higher and it can be confirmed that it is waste that comes from real consumers. In addition, the plant has a Solid-State Polymerization procedure that makes it possible to increase the strength and viscosity so that it is suitable for plastic resin molding by injection blow-molding as well as extrusion process as shown in Figure 13c.

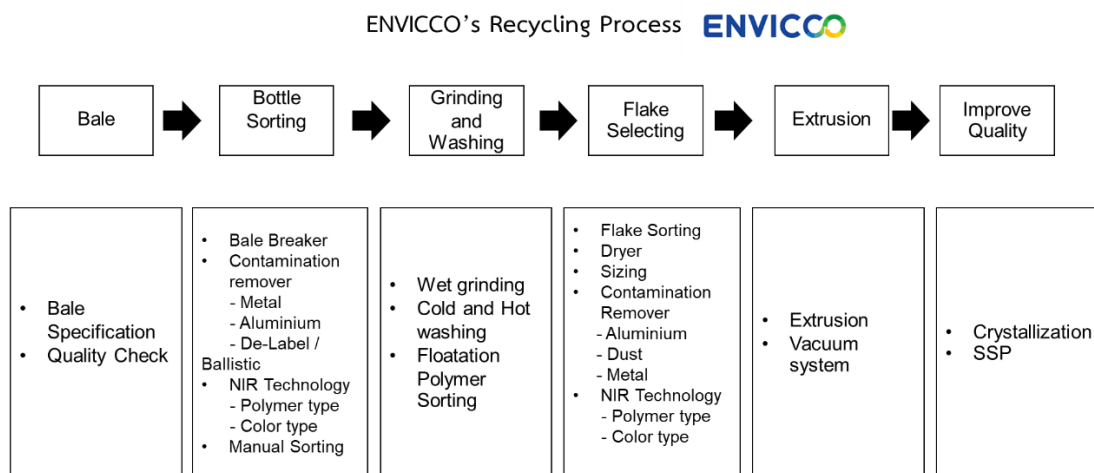


Figure 13c Envicco's Recycling Process (source: <https://envicco.com/th/products>)

environmental awareness among consumers, which affects their purchasing choices. Starting the management of plastic waste from packaging in all sectors can be initiated and successfully accomplished through several key factors:

1. **Building Knowledge, Understanding, and Awareness:** Educating and creating awareness about the proper separation of various types of plastic packaging waste is essential.
2. **Data Collection on the Source of Plastic Packaging Waste:** Collecting data on the origin of plastic packaging waste, such as from condominiums or communities, enables confirmation that the recycled plastic pellets indeed come from previously used plastic waste.
3. **Support, Regulations, and Policies:** Support and regulations from government bodies play a crucial role in expediting the management of plastic waste from packaging.

If all sectors start to manage plastic packaging waste correctly and efficiently this can lead to an improvement in the quality of plastic waste generated from consumption that enters the production process. This can reduce the amount of plastic waste sent to landfills and result in more environmentally friendly waste management. The move towards a circular economy (CE) must be driven by actioning throughout the whole system to include producers, entrepreneurs, and consumers as presented in Figure 14b as we must work together to make changes for a sustainable future.

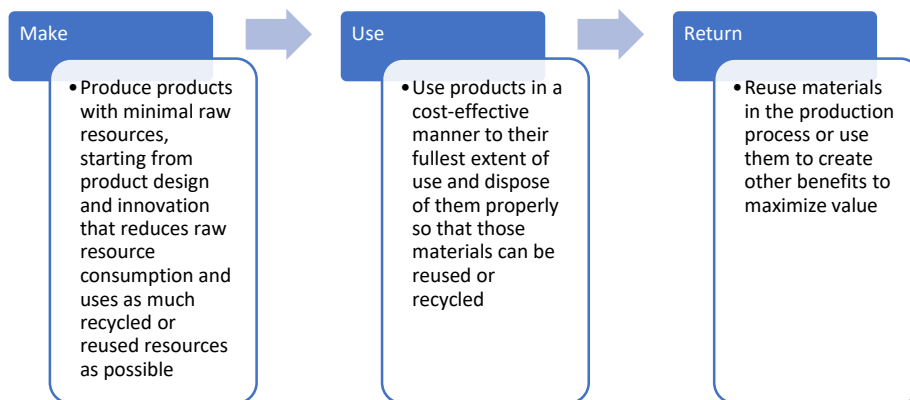


Figure 14b Moving towards a circular economy

The most important thing is to understand where the organization stands in the Circular Economy (CE) process and then start by making changes to what is currently being done to pave the way for the organization's sustainability in the future.

Chapter 15 Summary from CE product verification guideline handbook

15.1 Summary of key points in the guideline handbook

The guideline handbook for CE product verification on Lancang-Mekong Region Countries has been developed to assist organizations in implementing sustainable practices in their supply chains. The handbook provides comprehensive guidance on the requirements of CE product verification, including the relevant standards and certifications, monitoring and evaluation, and case studies of successful implementation. The handbook outlines the importance of monitoring and evaluating the implementation of CE product verification in the supply chain, providing guidance on measuring progress and making necessary adjustments. The case studies and examples included in the handbook provide real-world examples of how organizations have successfully implemented CE product verification, highlighting the benefits and challenges of the process.

One key takeaway is the importance of choosing the appropriate standard or certification for the business and the product being produced. Each standard and certification have its own set of criteria, and it is essential to choose the one that aligns with the company's goals and values. Additionally, monitoring and evaluating the implementation process is crucial to ensure that the intended goals are being met and to make any necessary adjustments. The guideline handbook also provides guidance on measuring and tracking progress, as well as making adjustments as necessary. This involves setting measurable goals and regularly monitoring progress to identify areas that require improvement. By doing so, businesses can ensure that they are continuously improving their sustainability practices and meeting their commitments.

Overall, the guideline handbook for CE product verification in Lancang-Mekong Region Countries provides businesses with a comprehensive guide to implementing sustainable practices in their supply chain. By following the guidelines outlined in this handbook, businesses can reduce their environmental impact and promote sustainability while also improving their bottom line.

15.2 Importance of CE product verification for achieving a circular economy

CE product verification is an important step towards achieving a circular economy, which aims to minimize waste and maximize the use of resources. The circular economy model is based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. CE product verification is an essential tool for ensuring that products are designed and manufactured according to these principles and that they meet the standards and certifications required for environmental sustainability. CE product verification involves monitoring and evaluating the entire supply chain, from raw material sourcing to end-of-life disposal or recycling. By implementing CE product verification, businesses can ensure

Chapter 16 Summary of train the trainer course for Thai experts and training course for Mekong- Lancang region countries

MASCI hosted train the trainer training “Circular Economy (CE) Capability Building in the Lancang-Mekong Region: Product Verification of Plastics Packaging in Supply Chains Training” The training took place online through the Zoom platform from May 29 to June 2, 2023. The event was honored by the presence of experts in Circular Economy (CE) from both international arenas and Thailand. These experts shared their knowledge and experiences related to the review of CE products, with a specific focus on plastic packaging in the supply chain. The training was attended by more than 55 participants, including professionals from various sectors such as government agencies, private enterprises, industry network institutions under the Ministry of Industry, and educational institutions in Thailand.



Session Experts

Mr. Chris Oestereich



Chris Oestereich is a circular economy consultant, writer, and an adjunct faculty member for Thammasat University's School of Global Studies. He currently leads Linear to Circular, a social enterprise that helps organizations rethink systems for broad benefits, and he's launching Morph, an upcycling brand that makes useful things from waste. Chris is also a co-founder of the Circular Design Lab, an open innovation platform that teaches community members to work on local challenges.

Dr. Jiafu Su



Dr. Jiafu Su is an Associate Professor of Chongqing Technology and Business University (CTBU) in China. His research expertise and interests include innovation management, green supply chain and Circular Economy. He has published more than 50 SSCI/SCI papers.

Ms. Souksaveuy Keotiamchanh



Souksaveuy is a founder of Zero Waste Laos, working on waste management, climate change and youth development for sustainability engaging with private, government and development sector partners. Souksaveuy has gained expertise in CE in Laos through supporting the development of National Plastic Action Plan in Laos and conducting the assessment of the plastic waste situation in Vientiane as well as implementing projects with communities. She was the 2022 winner of the Women of the Future Awards S.E. Asia in the ESG category. She has a Master's Degree in Environmental Engineering and Management from the Asian Institute of Technology.

Dr. Sidxay Makvilay



Dr. Sidxay Makvilay is Deputy Head of Environment Policy Division, Department of Environment, Ministry of Natural Resources and Environment (MONRE), Lao PDR. His work focuses on pollution prevention and waste management including plastic waste management. He is working on developing and implementing laws and regulations as well as strategy plans related to dealing with plastic pollution in Laos. Currently, he is drafting a decree on waste management and working on the national plastic action plan for Lao PDR.

Assoc. Prof. Pakpong Pochanart



Prof. Pochanart is the Dean of the Graduate School of Environmental Development Administration at the National Institute of Development Administration (NIDA). He has a Ph.D from the University of Tokyo and is an expert in the areas of Atmospheric Chemistry and Air Pollution, Environmental Science and Technology, Climate Change, Environment and Sustainability and Sustainable Business.

Plastic Institute of Thailand, PITH

Mr. Kongsak Dokbua



Mr. Dokbua, Vice President at PITH, has led many projects and studies in the area of plastic recycling in the overall scope of CE and is a member of the Permanent Secretariat of the ASEAN Federation of Plastics Industries (AFPI).

Mr. Nattula Wongta



Mr. Wongta, Supervisor Standard Testing Section at PITH, works on the development and promotion of The Bioeconomy Industry, the transformation of the Bio-Plastics Industry and assisting the move towards Thailand 4.0.

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3. Initiatives of China's Circular Economy

3.5 Resource Regeneration and Recycling

- Improve the recycling network of waste materials
- Improve the processing and utilization of renewable resources
- Standardize and develop the second-hand commodity market
- Promote high-quality development of the remanufacturing industry

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Feedstocks

- Manure (e.g., dairy, swine, beef, poultry)
- Wastewater Biosolids (e.g., municipal sewage sludge)
- Food Waste (e.g., household, restaurant, cafeteria, grocery, food)
- Other Organics (e.g., energy crops, fats, oils, grease, crop residue, winery/brewery waste)

Feedstocks can be digested singularly or in combination (co-digestion)

Anaerobic Digestion

Biogas

- Bioproduct Feedstock (e.g., bioplastics)
- Electricity
- Heat
- Vehicle Fuel
- Renewable Natural Gas

Digestate

- Horticulture Products (e.g., soil amendment, peat moss replacement, plant pots)
- Other Products (e.g., building material)
- Crop Irrigation
- Animal Bedding

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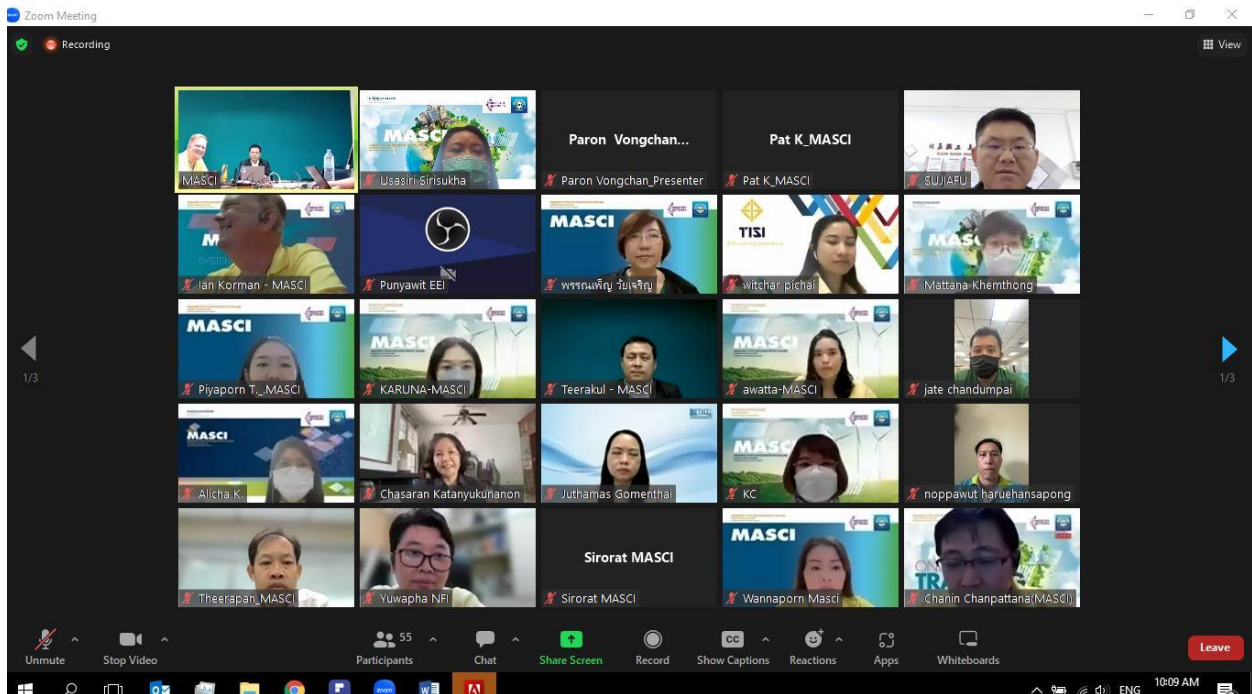
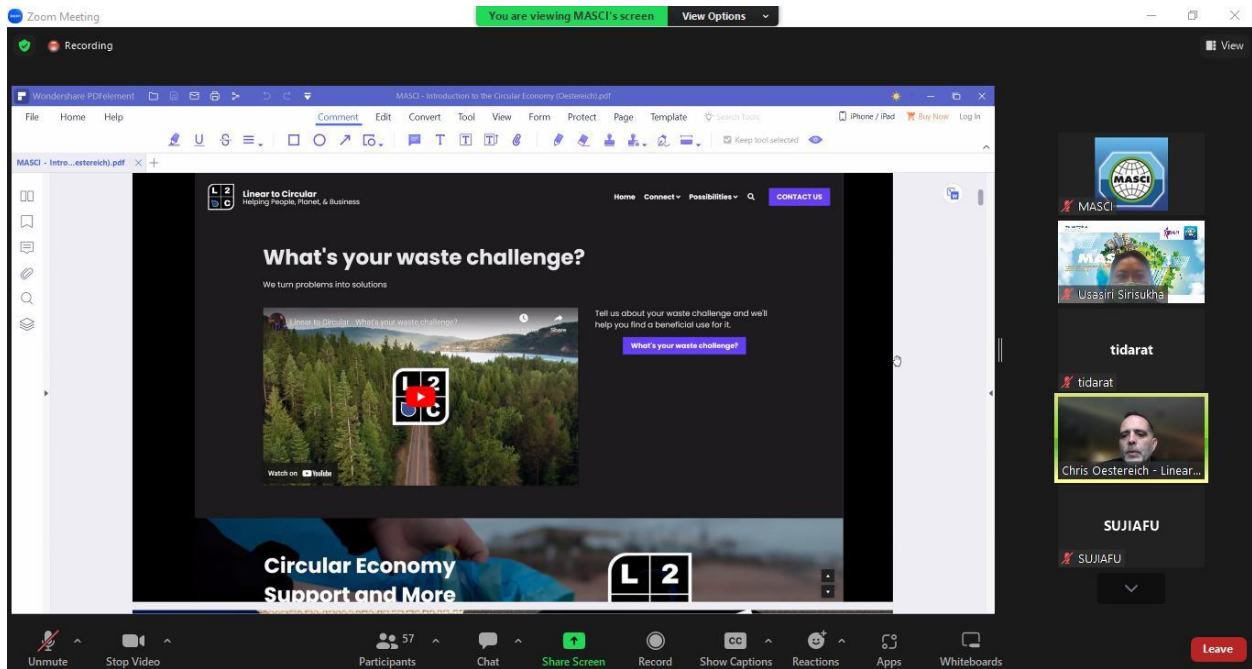


Figure 16a Train the trainer course from May 29 to June 2, 2023

MASCI hosted the "Circular Economy (CE) Implementation Training: Product Verification for Plastic Packaging in Supply Chains" at The Berkeley Hotel Pratunam from August 7 to 11, 2023. The primary objective of the training was to share knowledge on CE product verification, drawing insights from successful cases across various countries, regions, and international organizations. The target audience included participants from Mekong Region countries, namely Cambodia, Laos, Myanmar, Vietnam, and Thailand, with a total of 60 attendees representing government agencies, the private sector, and educational institutions.

The training aimed to bolster the industrial competitiveness of Mekong Region countries by applying CE concepts within supply chains, thereby contributing to the accelerated attainment of Sustainable Development Goals (SDGs). Specifically, the focus was on SDG 11: Sustainable Cities and Communities, SDG 12: Responsible Consumption and Production, and SDG 13: Climate Action.

This training marked a significant milestone in fostering collaboration among Mekong Region countries and China, aligning with the shared goal of achieving sustainable growth in the future. The participants completed the pre-and post test to understand and evaluate their understanding on CE product verification. Below is the summary of training each day.

First day of the training workshop: participants delved into various topics, including BCG Policy and Initiatives in Thailand, circular economy principles and concepts, and an introduction to the process verification scheme related to CE products. One instructor outlined the Ministry of Industry's roadmap for the circular economy strategy spanning 2022-2027, emphasizing seven target industries: plastics, tires, construction materials, steel & other metals, electronics, solar panels, and EV batteries. The presentation included insights into success stories and challenges encountered in the journey toward a circular economy. Another instructor provided valuable information about the roles of Thai Industrial Standards Institute (TISI) in the CE Certification scheme, and discussion of specific standards such as TWA 4002-2565 for circular design for PET bottles and TWA 4004-25xx for design recommendations for recyclable packaging (D4R). Challenges in implementing circular economy practices were highlighted, encompassing financial and investment barriers, consumer behavior considerations, limited awareness, and understanding, as well as institutional and regulatory hurdles. Financial constraints, potential resistance from consumers, and a lack of awareness and understanding were identified as potential obstacles.

On the flip side, opportunities in the circular economy were discussed, including the potential for policy and regulatory reforms to incentivize circular practices, collaboration and partnerships to foster innovation, and financial support from governments to encourage the development of circular solutions. The session concluded with participant evaluations to gauge their comprehension of the presented subjects. Summary of CE process verification scheme can be seen in Figure 16a

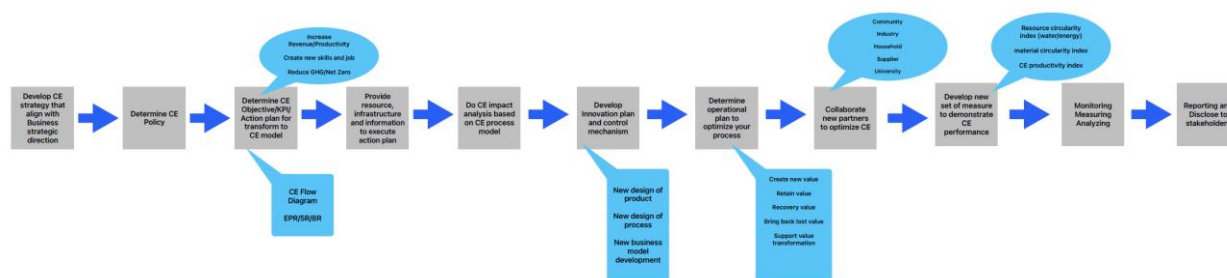


Figure 16b Summary of the overview CE process verification scheme

Second day of the training workshop: The following topics were presented to participants during the workshop: Introduction to Chain of Custody: Principles and Concepts, Verification Process and Methodology, Verification Scheme Workshop: Developing Verification Scheme for CE Product, and Exercise of Integration of Knowledge to Develop CE Product Verification Based on Country Context. The workshop focuses on the development of a comprehensive CE product verification standard for the plastic supply chain, specifically targeting industries involved in recycling plastic bottles, recycling plastic bags, recycling food storage containers, and producing plastic products from recycled materials. Participants engage in collaborative tasks outlined in Table 16a.

Table 16a Collaborative tasks on the development of a comprehensive CE product verification standard for the plastic supply chain

Task	Topic	Detail
1	Selecting the Industry	Participants collectively choose one specific industry within the plastic supply chain as the focal point for standard development.
2	Drawing the Value Chain (Schematic Overview)	Participants sketch a schematic overview of the selected industry's value chain, identifying key stages and stakeholders to visualize material and information flow.
3	Determining the Chain of Custody Model	Integrating the Chain of Custody (CoC) Model into the value chain, participants identify points where CoC is established to track the flow and handling of recycled plastic materials.
4	Adopting the Functional Approach for Standard Development	<ul style="list-style-type: none"> a. Selection Stage: Identify criteria and requirements for businesses to be eligible for CE certification. b. Determination Stage: Define environmental and sustainability performance indicators for CE certification. c. Review and Attestation Stage: Establish the third-party verification process for compliance. d. Surveillance Stage (Optional): Design monitoring mechanisms for ongoing compliance.

Task	Topic	Detail
5	Drafting the CE Product Verification Standard	Participants collaborate to draft a comprehensive CE product verification standard based on the outcomes of previous tasks.
6	Feedback and Review	Groups exchange work, providing feedback on clarity, completeness, and feasibility of proposed requirements.
7	Audit Objective Evidence	Participants outline objective evidence for audits to verify compliance with the CE Product Verification Standard, including documentation and records. By the workshop's end, a tailored standard is developed, promoting sustainable practices and recycled material usage within the selected industry of the plastic supply chain.

The verification process of CE products for second day of the training workshop is shown in Figure 16b.

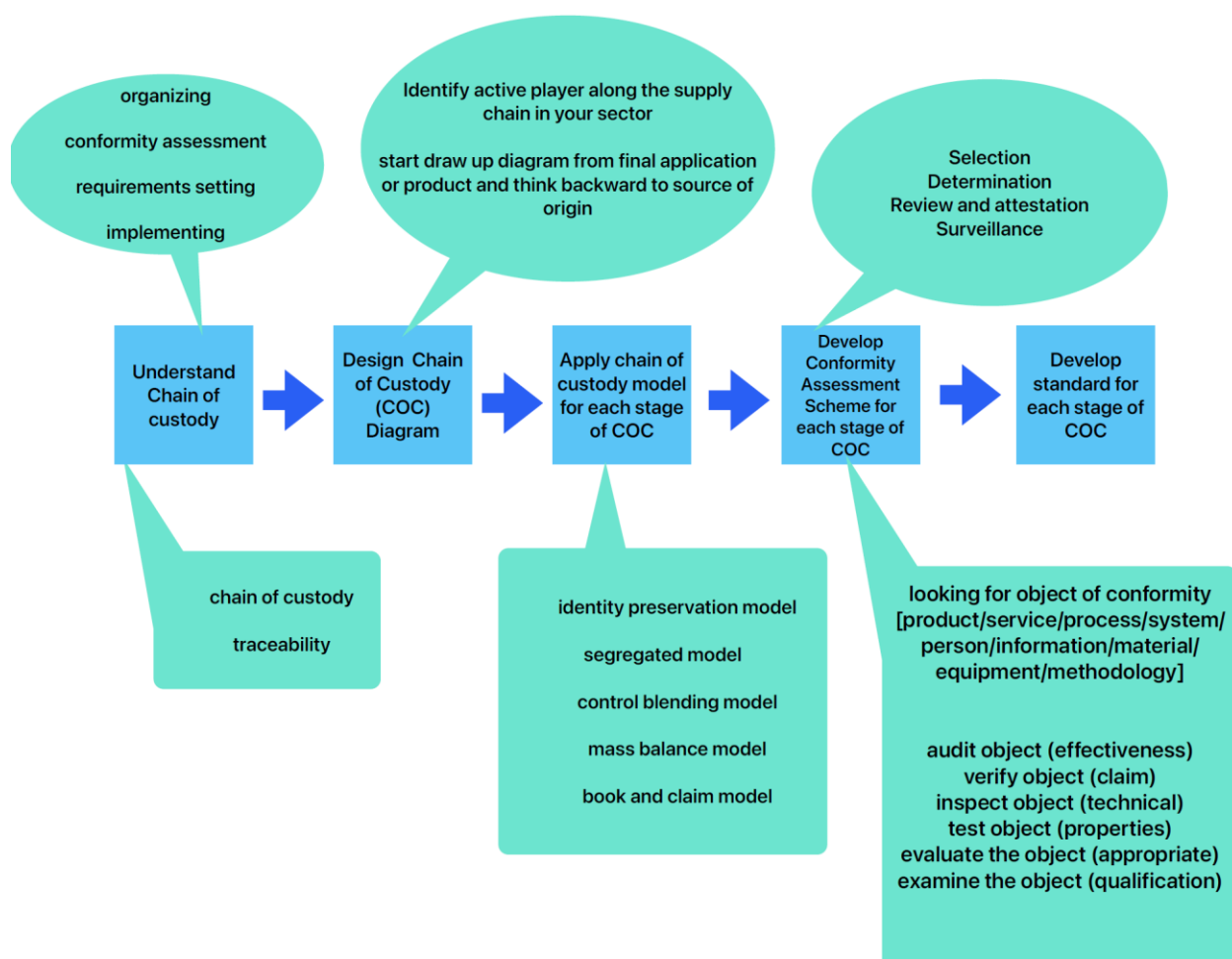
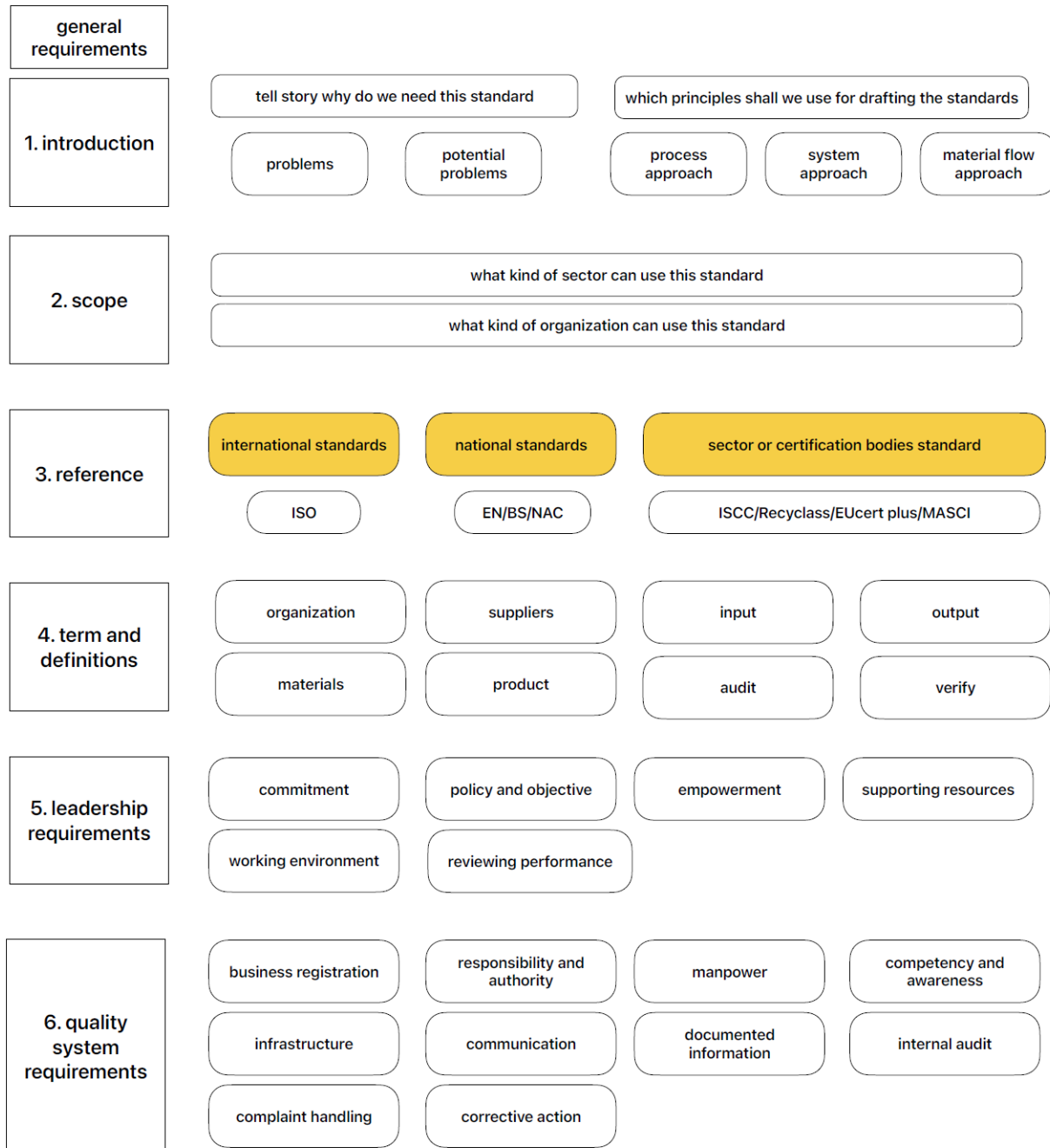
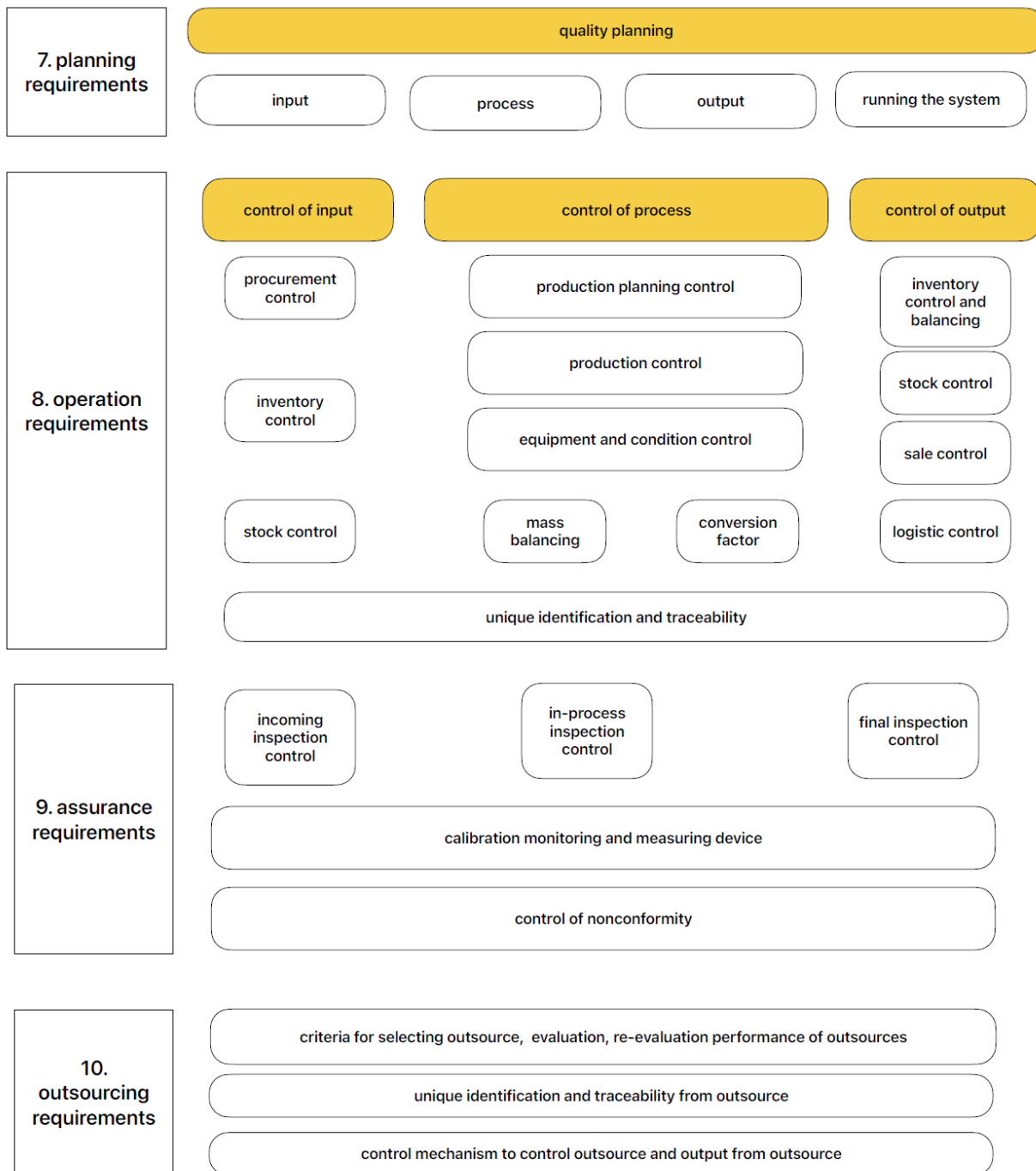


Figure 16c Verification of CE products for second day of the training workshop

Third and fourth day of the training workshop: The training workshop covers the following topics: traceability and conformity assessment for plastic recycling, requirements for recycled plastic products and their implementation, and a verification workshop focusing on verification topics and objective evidence. A summarized overview of the training workshop is depicted in Figure 16c.





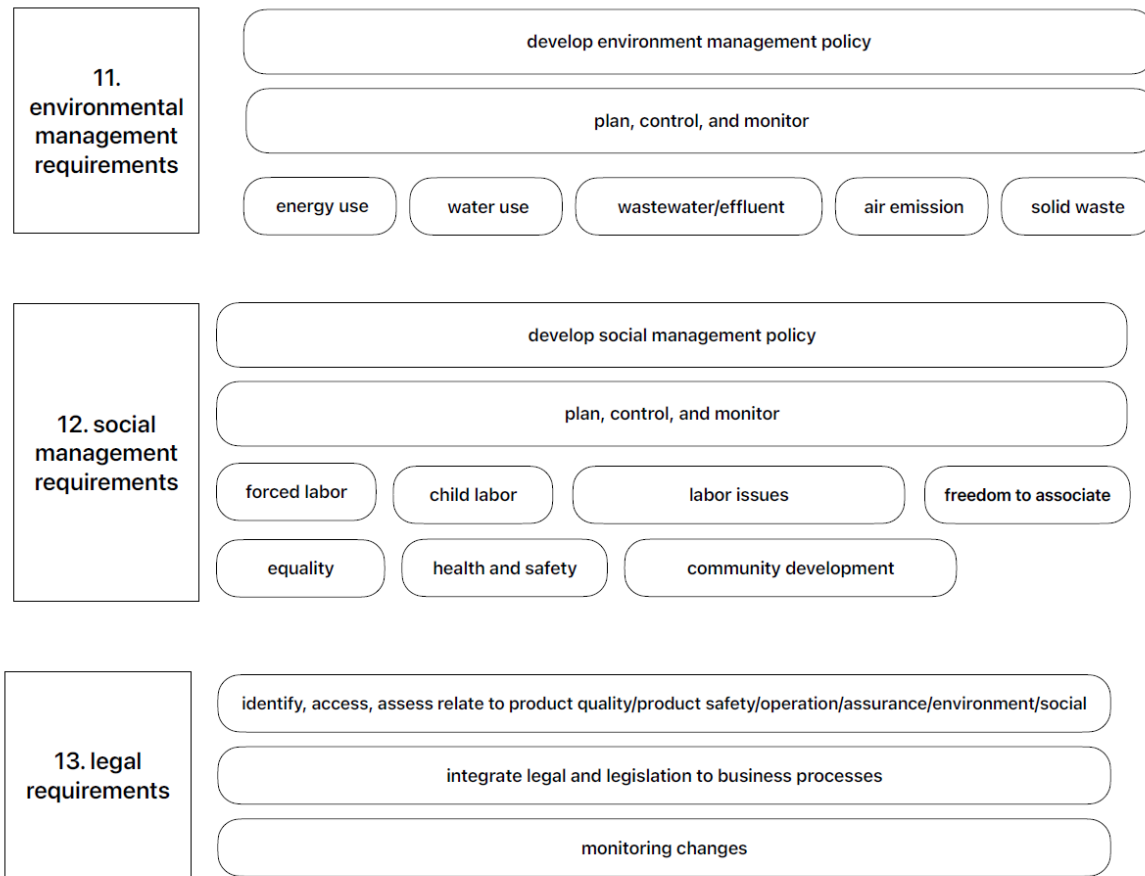


Figure 16d The summary of the day 3-4 training workshop

Last day of the training workshop: Instructor has shared insights into CE product verification based on Siam Cement Group (SCG). As one of Thailand's largest conglomerates, SCG delivers high-quality products and services through a commitment to excellent processes, technological development, and innovation, positioning itself as one of ASEAN's foremost sustainable enterprises. SCG is actively working towards becoming the "Chemicals Business for Sustainability," aligning its operations with ESG principles and striving to balance the triple bottom lines, encompassing tangible and intangible capitals. As part of its sustainable initiatives, SCG has ambitious plans to inaugurate Thailand's first demonstration plant in Rayong, with a recycling feedstock capacity of 4,000 mt/year. This cutting-edge facility is designed to transform post-consumer plastics into recycled feedstock, and it has obtained ISCC PLUS certification for the entire supply chain.





Figure 16e Training CE implementation workshop from August 7 to 11, 2023

Chapter 17 summary of results from survey of the CE Implementation Training

This summary includes 1) the pre-test results from CE Implementation prior Training - Product Verification for Plastic Packaging in Supply Chains Training Evaluation, 2) summary results of open-ended questions.

17.1 The pre-test results from CE Implementation prior Training -Product Verification for Plastic Packaging in Supply Chains Training Evaluation.

The score of the pre-test of CE product validation prior training for plastic packaging in the supply chain knowledge were categorized into 5 Levels (5 = Superior, 4 = Above Average, 3 = Average, 2 = Below Average, 1 = Weak, and 0 = Without Knowledge). The results from the pre-test results of the knowledge level score are summarized in Table 16a.

Table 17a Pre-test results of the knowledge level score before CE Implementation training

Topic	Percentage of respondent in each score (Total 49 respondents)						
	Score	0	1	2	3	4	5
1. Global trends and challenges in Plastic Industry	<u>4.1</u>	14.3	28.6	34.7	10.2	8.2	
2. BCG Policy and Initiatives in Thailand	12.2	32.7	30.6	16.3	<u>4.1</u>	<u>4.1</u>	
3. Circular Economy Principles and Concepts	<u>4.1</u>	8.2	38.8	26.5	16.3	6.1	
4. Process Verification Scheme Related to CE Product	8.2	22.4	36.7	18.4	10.2	<u>4.1</u>	
5. Chain of Custody Principles and Concepts	14.3	24.5	36.7	16.3	<u>4.1</u>	<u>4.1</u>	
6. Conformity Assessment	12.2	12.2	34.7	28.6	8.2	<u>4.1</u>	
7. Developing Verification Scheme for CE product	16.3	16.3	42.9	<u>8.2</u>	<u>8.2</u>	<u>8.2</u>	
8. Requirement Setting for process or product traceability	14.3	20.4	40.8	10.2	8.2	<u>6.1</u>	
9. Requirements and implementation for related social issues	10.2	12.2	40.8	22.4	8.2	<u>6.1</u>	
10. Knowledge and Experience Sharing from SCGC in process verification	28.6	10.2	36.7	10.2	8.2	<u>6.1</u>	

Bold represents the maximum number. Underline represents the minimum number.

17.2 Summary results of open-ended questions

The questions asked about participants work experiences on Circular Economy (CE), the status quo of CE. There are 14 respondents from 3 countries. Respondents are from government sectors and 1 private sector. The respondents' overall information is summarized in Table 16b.

Table 17b Overview of respondents

Country	Organization	Role	Experience on CE
Cambodia	Deputy Chief Office, Ministry of Industry, Science, Technology & Innovation	n/a	0
Cambodia	Deputy Director, Institute of Standards. Ministry of Industry, Science, Technology and Innovation	a member of national regulatory body for controlling products' standards	0
Cambodia	Deputy Chief Officer, Ministry of Industry, Science, Technology & Innovation	Department of Accreditation. Implementing scope of ISO/IEC 17025.	0
Myanmar	Deputy Director, Ministry of Science and Technology, Department of Research and Innovation	n/a	3 years
Cambodia	Vice Chief of Product Registration Office, Ministry of Industry, Science, Technology and Innovation (MISTI), Department of Regulatory / Institute of Standard of Cambodia	n/a	0
Cambodia	800 Super-GAEA (Cambodia) Co., LTD, solid waste management (private sector)	n/a	n/a
Cambodia	Ministry of Environment, Solid Waste Management Department	a technical inspection group to inspect in the industrial sector for environmental management, especially solid waste management.	n/a

Country	Organization	Role	Experience on CE
Cambodia	Vice Chief Office, Ministry of Environment, Water Quality Management	n/a	0
Cambodia	Vice Chief Office, Ministry of Environment, Hazardous Substances Management	Hazardous Waste Management Bureau in Hazardous Substances Management Department.	
Lao PDR.	Head of agriculture department, Agriculture Department	n/a	0
Cambodia	Chief office, Institute of Standards of Cambodia of Ministry of Industry, Science, Technology & Innovation, Certification of Department	Department of Certification, Institute of Standards of Cambodia. Control the use of recycling plastic bottle for drinking water.	0
Cambodia	Chief of Chemical Management Office, Institute of Standards of Cambodia, MISTI, Department of Regulation	n/a	n/a
Vietnam	Technical Consultant of Circular Economy (CL2B)	<ul style="list-style-type: none"> -Led and managed projects, developing detailed plans and budgets to ensure successful implementation of initiatives: -Recruited project teams and effectively coordinated their activities to ensure smooth project execution. -Engaged and collaborated with diverse stakeholders and facilitated collaboration to foster cooperation and achieve project goals. 	3

Country	Organization	Role	Experience on CE
		-Delivered training sessions to waste managers to improve workflow efficiency and enhance sustainability practices.	
Myanmar	Deputy Director Ministry of Science and Technology National Standards and Quality Department/ Standards	National Standards and Quality Department. The responsibility is to develop national standards with administrative functions and cooperation with standards technical committee and stakeholder. Preparing standards training to relevant stakeholders. I am also responsible to implement the National Certification activities in Myanmar.	0

Table 17c concludes the Q&A from open-ended questions replied by the respondents.

Table 17c Q&A from open-ended questions replied by the respondents.

Question	Reply from respondents
<p>Please explain about CE policy in your organization. How long have you been implementing it? Since when? Why does your organization adopt CE?</p>	<p>The Ministry of Industry, Science, Technology and Innovation, Cambodia (MISTI) is the responsible ministry for industrial policy and innovations. These are outlined in the Cambodia Industrial Development Policy (2015 – 2025) and the National Strategic Plan on Green Growth (2013-2030). Ministry of Environment has adopted the CE Strategy and Action Plan in 2021 which outlines the key vision, mission, strategy, and roadmap for Cambodia to shift towards a circular economy. Moreover, MoE has endorsed the roadmap for sustainable consumption and production in Cambodia (2022-2035) as the 14 years plan to improve the sustainability of Cambodia’s consumption and production system through strategic and action plan of short, medium, and long-term plans.</p> <p>CE policy has been developed in 2021 by the Department of Green Economy of Secretariat General for Sustainable Development (GSSD), National Council for Sustainable Development (NCSD) of the Ministry of Environment (MoE), Cambodia.</p> <p>CE strategy and Action Plan identified goals to achieve the sustainable development including: (1). Increase sustainable production and energy use, (2). Increase sustainable consumption, (3). Reduce waste generation, (4). Improve effectiveness of waste collection, management, segregation, and transport, (5). Promote product reuse and repair, (6). Increase recycling, composting and energy recovery, (7). Ensure environmental control at all</p>

Question	Reply from respondents
	<p>waste management sites and (8). Promote widespread environmental education and awareness raising. CE has been adopted in MoE because we would like to enabling the country to achieve a prosperous economy, a thriving and inclusive society, and healthy environment.</p> <p>Some of the participants are from private sectors e.g. consulting firm. They provide consulting services for developing CE policy for our clients.</p>
<p>If your organization has not yet adopted CE implementation, at what stage your organization is in implementing CE?</p>	<p>In the case of Cambodia, the country’s strong economy and increasing population has resulted in a sharp increase in use of materials and energy and a surge in waste generation. This situation presents a significant challenge for the sustainable management of energy, resources and waste. CE enables the improvement of many aspects of the economy and society for Cambodia and the attainment of environmental sustainability. Broadly adopt CE models can significantly reduce the use of natural resources and energy, as well as GHG emissions, water and air pollution, and waste generation.</p> <p>For participants from the national regulatory body for controlling and checking products’ national standards and technical regulation, their roles are to develop standards for CE products.</p> <p>Some participants mentioned environmental friendly behavior in minimize resources, reuse paper in their organization as part of CE practice.</p> <p>“I don’t think my idea is absolutely right but I think how I use A4 paper in my organization/ work is a part of implementing CE because I reuse it on another page of A4 paper used in order to reduced the waste of using paper as we know that paper is made from tree. So, it’s a part of saving tree as raw material and can protect our world from any disaster or climate change.”</p> <p>Participants from Vietnam can add the CE implementation cases. Other participants cannot provide examples of CE case in their countries. In Vietnam, Vinamilk has initiated sustainable packaging to reduce plastic waste and improve the company's brand image. Vietnam's effective management of electronic waste through recycling centers has minimized environmental hazards and created job opportunities.</p>
<p>Challenges in CE implementation</p>	<ul style="list-style-type: none"> - Lack of Policy and Law Support for Private Sectors/SMEs: Insufficient government policies and laws supporting private sectors and small and medium enterprises (SMEs) hinder their adoption of circular practices. Comprehensive support measures are needed to create an enabling environment through policy frameworks, financial incentives, and regulatory measures. - Limited Consumer Awareness: There is a lack of awareness among consumers about the benefits of the Circular Economy. Insufficient education and awareness campaigns have resulted in a limited understanding of sustainable consumption habits, recycling, and responsible waste management practices. This hampers the demand for circular products and services. - Lack of Business Motivation and Commitment

Question	Reply from respondents
	<p>Some businesses lack motivation to adopt circular practices due to limited understanding of economic benefits, concerns about initial investment costs, and a focus on short-term profitability rather than long-term sustainability. Incentives and support are needed to showcase the economic advantages of circular business models. Low commitment from to management and stakeholders, don't have quality system, planning and controlling system.</p> <ul style="list-style-type: none"> - Reliance on Low-tech Downstream Solutions <p>As developing countries, CE implementation relies heavily on low-tech downstream solutions like recycling. While recycling is important, a comprehensive approach should also emphasize waste reduction, product reuse, and circular design. Encouraging innovation and advanced technologies throughout the value chain is crucial.</p> <ul style="list-style-type: none"> - Limited budgets especially for SMEs <p>SMEs face challenges in adopting circular practices due to initial investment costs. Transitioning to circular business models, such as product redesign or resource-efficient processes, may require upfront investments that SMEs struggle to afford. Financial support mechanisms and capacity-building programs are needed to assist SMEs in the transition. These challenges highlight the need for stronger policy support, increased consumer education, enhanced business motivation, advanced technological solutions, and financial assistance for SMEs to overcome barriers and successfully implement the CE</p>
<p>The Key elements that lead to CE implementation</p>	<ul style="list-style-type: none"> - Collaboration and Stakeholder Engagement <p>Effective CE implementation requires collaboration among various stakeholders, including government bodies, businesses, academia, non-governmental organizations (NGOs), and communities. In my opinion, the key element that leads to CE implementation is the willingness/commitment of the organization/institution both in the public and private sectors. They must show their responsibility to participation from each stakeholder in CE implementation.</p> <ul style="list-style-type: none"> - Policy and Regulatory Framework <p>Governments need to develop and enforce regulations that promote circular practices, provide incentives for businesses, and establish targets for waste reduction and resource efficiency.</p> <ul style="list-style-type: none"> - Awareness and Education <p>Educating consumers, businesses, and policymakers about sustainable consumption, waste reduction, and responsible resource management helps create a demand for circular products and services. Understanding on how our daily needs effect our surrounding living and non-living environment. People cannot practice/ implement something that they think it is not necessary. Thus, we need the implementation body to understand the important of CE and their willingness</p> <ul style="list-style-type: none"> - Financial and Economic Incentives

Question	Reply from respondents
	<p>Providing financial support, incentives, and favorable economic conditions play a significant role in driving CE implementation. Governments can offer tax incentives, grants, subsidies, and favorable financing options for businesses adopting circular practices, encouraging their participation.</p> <ul style="list-style-type: none"> - Circular Design and Innovation <p>Emphasizing eco-design, product durability, repairability, recyclability, and incorporating recycled or renewable materials promotes a circular approach. Encouraging innovation in business models, technologies, and processes further supports CE implementation.</p> <ul style="list-style-type: none"> - Communications <p>Clear and continuous communication among government and stakeholders (people, recycling industries etc.) are necessary to carry out CE implementation.</p> <p>Some participants especially from the standard development, they mentioned the process of development CE verification as part of CE implementation key elements 1. Understand the chain of custody (CoC) 2. Design the chain of custody (CoC) diagram 3. Apply chain of custody model 4. Develop conformity assessment scheme for chain of custody and 5. Develop standard for stage of chain of custody.</p> <p>Some participants mentioned about Climate change, Pollution (air and water), and virgin material shortages in the future are the key elements that leads to CE.</p> <p>From my point of view, key elements that lead to CE implementation is personally understanding and their willingness to protect and reduce environmental pollution. Otherwise, government and other relevant stakeholder willing to engage and set up a simplified guideline and standard for CE implementation. Integrated CE in industrial sector should be required.</p>
<p>Explain CE verification product/ process and methodology you apply in your organization, or your role involved in?</p>	<p>The specific methodology applied in CE verification product may vary depending on the organization, industry, and context. Methodologies that can be applied are LCA, Material Flow Analysis (MFA), and Social Impact Assessment.</p>
<p>Are there any key milestones that your organization or country has reached in implementing CE? Explain</p>	<p>Respondents can describe national plan on CE.</p> <p>In Cambodia, successful transition to a CE also requires the engagement of Micro, Small and Medium Enterprises (MSMEs) which play a vital role in Cambodia’s economy, contributing to economic and social progress. The Government’s Industrial Development Policy 2015-2025 sets out to develop and modernize Cambodia’s MSMEs through support in expanding and strengthening MSMEs’ manufacturing base, and by ensuring technology transfer and industrial linkages among MSMEs and other key players. In line with these aims, a CE approach can support MSMEs of any size through</p>

Question	Reply from respondents
	<p>facilitating access to energy efficient technologies which reduce overhead costs or to financial support for expanding reuse and repair businesses which are dominated by MSMEs. Recently, the Department of Solid Waste Management has been preparing the sub-decree of single-use plastic waste and product management. I believe this sub-decree will play a big role in the CE implementation for each sector to reduce plastic waste consumption and promote plastic waste recycling.</p> <p>Vietnam has made significant progress in implementing the CE and has achieved several key milestones. Here are some notable achievements:</p> <ul style="list-style-type: none"> - National Strategy on Green Growth <p>Vietnam adopted the National Strategy on Green Growth in 2012, which promotes sustainable development and the transition to a circular economy. This strategy sets the foundation for policy frameworks, targets, and initiatives related to CE implementation.</p> <ul style="list-style-type: none"> - Circular Economy Roadmap <p>In 2019, the Vietnamese government introduced the National Action Plan on the Circular Economy, outlining specific goals and actions to promote circular practices across various sectors. The roadmap focuses on waste management, resource efficiency, sustainable production, and consumption patterns.</p> <ul style="list-style-type: none"> - Plastic Waste Reduction <p>Vietnam has taken significant steps to tackle plastic waste. In 2019, the government launched the National Action Plan on Marine Plastic Debris Management, aiming to reduce marine plastic pollution. Various initiatives, such as banning single-use plastics in certain regions and promoting eco-friendly packaging, have been implemented to address the plastic waste challenge.</p>
<p>How do you plan to apply what you gain from this CE implementation training in your professional, organization, national or regional context?</p>	<p>Participants in the workshop understand CE concept, product verification for plastic packaging in supply chains, and learn cases from SCGC on CE product verification. Respondents, especially from the national standards body or policy makers, will attempt to develop standards/product verification for CE products, CE collector etc. The participants plan to apply knowledge gain from the workshop in 4 aspects.</p> <ul style="list-style-type: none"> - Continue to study CE product verification: deepen knowledge of methodologies like Life Cycle Assessment (LCA), Material Flow Analysis (MFA), and other relevant tools. - Training for colleagues or clients: Share knowledge and expertise by conducting training sessions for colleagues or clients. This will empower them to incorporate circular practices into their own work and decision-making processes. - Advise clients to build CE standards for their product: When advising clients, emphasize the importance of developing CE standards for their products, including plastic packaging, defining clear criteria and guidelines for circularity

Question	Reply from respondents
	<p>- Incorporate CE verification into consulting projects: Integrate CE verification into my consulting projects by offering assessment and verification services for products, specifically focusing on plastic packaging. Utilize the methodologies and tools I have studied to evaluate the circularity of the packaging, identify improvement areas, and provide recommendations for more sustainable alternatives.</p> <p>- Track and report progress: Establish a system to track and report the progress of my clients' CE initiatives.</p> <p>More detail from respondents can be seen below</p> <p>“What I gain from this CE implementation Training, First of all, I will share with my Co-Worker or my organization about how important of this training course. In my brief, it related to how we can reuse, reduce and recycle. One country, if there are a lot of pollutions, the government must spend a lot of money to solve this problem. As we can see that nowadays many disasters have been happening in many countries and was destroyed economic as well. Out of virgin material is what I used to wonder how can we do if we don't have it anymore. So, if we get together, we can help to save or heal the world and live in comfortable environment.”</p> <p>“This training course is really interesting and important for my organization since I get to know more in-depth about CE implementation and the Plastic standard in the global and regional context. Although it was technical training, I hope to apply what I have acquired to improve the policy and regulations regarding single-plastic products and waste management in Cambodia.”</p> <p>“CE is a strategy that developed by MoE, Cambodia, but it is received technical support from UNDP as policy expert. This strategy has not yet widely introduced and implement mean we are in the early stage of CE implementation. Once, the CE is required to implement or set up a specific required standard within the organization, I'm glad to apply the gain experience and knowledge of from CE training.”</p> <p>“Personally, I think I cannot say my organization is implementing the CE, but we participating in overseeing the CE implementation throughout the country. After this training, I think, during inspection or workshop, I can encourage the factory to implement CE, provide them consultation if they need. Also, I think my office should develop some new requirement for factory to recycling their waste as much as possible.”</p> <p>“The plan to apply CE implementation training in my organization includes such things as:</p> <ol style="list-style-type: none"> 1. Disseminate information and policies on circular economy implementation to directors and colleagues; 2. Bring information, lesson content, and policy on the circular economy into the green skills lessons or environmental subjects;

Question	Reply from respondents
	<p>3. Create regulations and policies to propose to the director for the implementation of the circular economy within the organization.” “I am not quite sure about the timeline to adopt or implementing CE but I will share my knowledge to my institute about the importance of implementing CE and will try to persuade my leader to consider about CE implementation.”</p>
<p>What plan that you believe you can achieve within 3-6 months. Please explain</p>	<p>Most respondents not sure when their organization will implement CE within 3-6 months but they will</p> <ol style="list-style-type: none"> 1) share knowledge/experiences from the training course to the top management and team in their organization 2) continue to study CE product verification: Stay updated on the latest research, case studies, and advancements in CE verification to enhance my expertise in evaluating the circularity of products, including plastic packaging 3) training for colleagues or clients: Provide workshops or educational programs to familiarize them with CE principles, the importance of CE verification, and methodologies for assessing circularity. <p>More detail from respondents can be seen below</p> <p>“Since we are in the stage of preparing the sub-decree on single-use plastic products and plastic waste management, I think I could share this knowledge and which and collaboration with other stakeholders related to CE implementation as much as I could.”</p> <p>“I could not provide a specific achievement within this period since we have not implemented in my department. I hope to introduce CE especially CE verification product in the guideline regarding with my current work and hope to be offered a chance to participated in CE procedure development including process, methodology, set up standard requirement mainly for environmental protection. So, I commit to work closely with relevant stakeholder in developing CE.”</p> <p>“It is hard for me to say what exactly I can achieve in 3-6 months. My office has planned to develop the guideline for hazardous waste management in industrial and household; thus, I hope I can include what I have learnt from this training in the guideline as much as possible.</p> <p>“Disseminate information and policies on circular economy implementation to directors and colleagues, and bring information, lesson content, and policies on Circular Economy into green skills lessons or environmental subjects.”</p> <p>“I don’t think that we can achieve within 3-6 months but I believe in two year later we will have policy on CE.”</p> <p>“I can’t predict the time that we can reach the CE implementation but as I know we have already thought about this and we just need more time to make the policy and implement it.”</p>