



# **Development of sustainable consumption and production indicators for industrial sector according to circular economy principles in Thailand**

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## **Abstract**

This research aimed to: (1) investigate the sustainable consumption and production indicators for industries as well as difficulties and limitations in using the indicators for the Eco-Factory program under the Federation of Thai Industries; and (2) develop the sustainable consumption and production indicators for Thai industries based on the Sustainable Consumption and Production Roadmap 2017–2037 and circular economy principles which are part of Thailand's long-term strategic plan of the national industrial development goals based on the BCG Model (Bio–Circular–Green Economy Model). At present, there is none of academic study on the Sustainable Consumption and Production (SCP) indicators for sustainable development at the micro level for industry in Thailand. This research focused on stakeholder involvement in developing indicators through surveys, an in-depth interview, a focus group meeting, a seminar, and a workshop. The study achieved the final version of SCP indicators (26 sets of indicators, 60 sub-indicators) consisting of 4 dimensions including environmental, social, economic, and good governance dimensions. Recommendations for implementation of indicators are (1) initiating a pilot project to support practical implementation in the industrial sectors based on industrial types including upstream, midstream, and downstream industries; (2) conducting a periodic review of the indicators, such as every 3 years by entrepreneurs and other sectors, and there should be standards, evaluation, and certification based on the circular economy standards of Thai Industrial Standard Institute (TISI); and (3) supporting the information provision and workshop at the first step to promote the readiness for the industries interested in the implementation, as well as supporting the sustainability reporting of indicator implementation, and creating a network of collaboration between industries.

**Keywords:** Sustainable development, sustainable consumption and production, indicator, circular economy, Thai industry

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**Article history:** Received 1 June 2021, Revised 29 October 2021, Accepted 29 October 2021

## **1. Introduction**

Thailand has strongly emphasized sustainable consumption and production (SCP) due to the limitation of natural capital as well as the ecological footprint, which is lower than the existing ecosystem capital. For the industrial sector, manufacture has exploited resources and simultaneously created an environmental impact from its production activities. After participating in the United Nations Conference on Environment and Development in 1992, Thailand developed various plans and strategies, which progress beyond other countries in the ASEAN Community, especially the 11<sup>th</sup> National Economic and Social Development Plan (2012–2016) to the 12<sup>th</sup> National Economic and Social Development Plan (2017–2021) proposed by the Office of the National Economic and Social Development Council (NESDC) to pursue the green growth

or green economy [1, 2]. Additionally, in 2019, the government promoted the New Sustainable Growth Engine or BCG model that includes developing bio-economy, circular economy and green economy concurrently. The model aims to develop the economy of the country and correspond to the Sustainable Development Goals as well as sufficiency economy that create a base for SCP operations [3]. The Office of Natural Resources and Environmental Policy and Planning (ONEP) identified strategies, adjusted consumption and production bases to eco-friendliness, and developed the 20-year Sustainable Consumption and Production Roadmap 2017–2036. The consumption and production goals are specified based on 3 main strategies comprising of lifting Thai society to meet sustainable consumption strategy, sustainable production strategy and supported factors for sustainability strategy [4].

Therefore, the SCP Roadmap of the manufactur-

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ing strategy has proposed the goal that “Thai industry becomes intended to be sustainable manufacturing industry in a socially responsible and environmental-friendly way as well as emphasizes on manufacturing process development, Green Industry certification, and integrated industrial waste management” [4]. It has specific indicators, such as the number of the factory that obtain the certificate of the Green Industry within 2021 with 2,000 additional green factories each year, and the number of industrial estates that are certified as Eco Industrial Town with the annual increase of not less than 4 estates [4] pp 13. However, the SCP Roadmap was revised in 2019 in which goals and objectives for industry sectors are more specifics and correspond to SDG12. There are 19 SCP indicators with targets required for industry sectors to achieve by 2037 [5].

Conforming to the Sustainable Industrial Development Policy 2015 presented by the government, the Federation of Thai Industries, the Industrial Estate Authority, and the private sector collaborate to develop Eco-Factory criteria for entrepreneurs in manufacturing sectors. The entrepreneurs who are certified can equate to achieving the Green Industry Level 4 [6]. There were 247 entrepreneurs in manufacturing sectors who achieved the certificate (in November 2020). The criteria of assessing Eco-Factory are based on sustainable industrial development principles which comprise of 14 aspects covering all dimensions (i.e., social, environmental, and economic dimensions), and they are also specified as indicators of sustainable industrial development [6].

Accordingly, the development of SCP indicators is important in following up the achievement of implementation objectives based on SCP policies. Since the policies are complicated, related to process in diverse dimensions, and associated with many organizations (i.e., public sector, private sector, and civil society organizations), the objectives and goals of the policy implementation cannot be achieved if the indicators are not suitable. Besides, “the data implementation of sustainability industrial indicators is in a limited group or limited area, which conduce the data of developing sustainable development guidelines.” [4].

As observed, in Thailand there is no study concerning the current sustainability indicators of the Thai manufacturing sector (micro level) whether they are practically suitable to the industrial development as well as the limitations of using these indicators in the contexts of national policies that support the economic growth under green economy and corresponding to the circular economy principles. Thus, the study on development of sustainable consumption and production indicators for industrial sector according to CE principles in Thailand will be very beneficial for relevant sectors as well as in assessing goals achievement stated in the SCP Roadmap of Thailand.

## 2. Research Questions

1. What are the obstacles and limitations in implementing the existing sustainable development indicators for industries in Thailand?
2. What sustainable consumption and production indicators for Thai industries based on the Sustainable Consumption and Production Roadmap 2017–2037 and circular economy principle should be?

## 3. Research Objectives

1. To investigate obstacles and limitations in implementing the existing sustainable development indicators for industries in Thailand under the Eco-Factory program initiated by the Industrial Estate Authority of Thailand and the Federation of Thai Industries.
2. To develop sustainable consumption and production indicators for Thai industries based on the Sustainable Consumption and Production Roadmap 2017–2037 and circular economy principles.

## 4. Research Methodology

This qualitative study was conducted using the grounded theory as well as top-down and bottom-up approaches in developing indicators. These approaches were accepted as a suitable process of the indicator development for practical implementation [7]. The target group of this study including 8 groups of industries certified as the Eco Factory, generating 64% of the GDP original from manufacturing at current market prices in 2017 [8]. There were 168 industries including industries of food products, coke and refined petroleum products, chemicals and chemical products, rubber and plastic products, computer, electronic and optical products, electrical equipment, motor vehicles, trailers, semi-trailers, and other transport equipment, which obtained 67% of the total number of 247 certified Eco Factory (in November, 2020).

### 4.1 Development of the First Draft of SCP Indicators

The research procedures began with reviewing the literature such as reports and researches related to the national policy on sustainable development and the sustainable indicator development at the industrial level in Thailand and other countries in order to develop the 1<sup>st</sup> draft of SCP indicators. The conceptual framework is shown in Figure 1.

### 4.2 Revision of the Developed SCP Indicators: The Second Draft of SCP Indicators

A survey (no. 1) and an in-depth interview with the representatives of target industries were then conducted to gather comments on the 1<sup>st</sup> draft, and the indicators were revised based on the comments as the 2<sup>nd</sup> draft of SCP indicators.

#### 4.3 Finalization of SCP indicators.

The 2<sup>nd</sup>-draft indicators were considered through a focus group discussion and a survey (no. 2) of the Eco Factory working group comprising representatives of the public and private sectors. After that, the suggestions from the seminar were used to improve the indicators as the 3<sup>rd</sup> draft of SCP indicators. Finally, the 3<sup>rd</sup>-draft indicators was validated through a workshop and a survey (no. 3) by representatives of the target entrepreneurs and the Eco Factory working group to consider the implementation practicality as well as to investigate the difficulties and recommendations. Then the summarization of the research result was made.

### 5. Results and Discussions

The development of sustainable development indicators for Thai industries is corresponding to the international sustainable development indicators, Eco Factory criteria, and the SCP Roadmap based on the CE principle, which contains 4 dimensions considered as 4 pillars for SD. In addition, the indicators associated with the policy indicators as well as micro- and macro-level indicators. To make a theoretical conclusion of the sustainable development indicators for Thai industries, the drafts of developed SCP indicators were examined by the stakeholders who play a role in developing and implementing the sustainable development indicators for Thai industries and have been working on this issue for more than 5 years. The main findings are as follows:

#### 5.1 Development of the First Draft of SCP Indicators.

As mentioned in 4.1, the 1<sup>st</sup> draft of SCP indicators was developed based on the framework. It consisted of 28 sets of indicators and 78 sub-indicators. The literatures reviewed for developing the 1<sup>st</sup> draft of SCP indicators are:

1. International academic studies conducted on the industrial indicators for sustainable development, sustainable production and sustainability. GRI and Sustainability Assessment of Food and Agriculture Systems (SAFA) [11]-[15].
2. Eco Factory criteria [6].
3. Thai SCP Roadmap specifying goals, targets, and indicators for Thai industries as the national plan [5].
4. Six principles under the circular economy concept are applied into drafting the indicators [10].

#### 5.2 Revision of the Developed SCP Indicators: The Second Draft of SCP Indicators.

The 2<sup>nd</sup> draft of SCP indicators was developed after conducting the 1<sup>st</sup> survey (20 respondents, 76 representatives of the factories) and the in-depth interview (6 respondents) with target industry. The 1<sup>st</sup> draft

of SCP indicators was revised and improved based on suggestions of the survey and the in-depth interview as shown below.

1. Environmental indicators. Sub-indicators of materials resource efficiency, water and wastewater intensity, and greenhouse gas emission intensity were adjusted by measuring per product instead of the monetary and avoiding absolute value sub-indicators. Air emission management efficiency should be modified to the volume of air emission reduction to show the higher performance. The logistics indicators should be added as the number of accidental sub-indicator and complaints of product transportation process per year.

2. Social indicators. The proportion of permanent and temporary staff sub-indicator should be deleted from the employee indicators due to the impracticality of employment in the business.

3. Economic indicators. The ratio of standard entry level wage by gender compared to local minimum wage at significant locations of operation sub-indicator should be deleted from the cost/expense indicators as it was not practical for employment in some businesses and there were various types of industry.

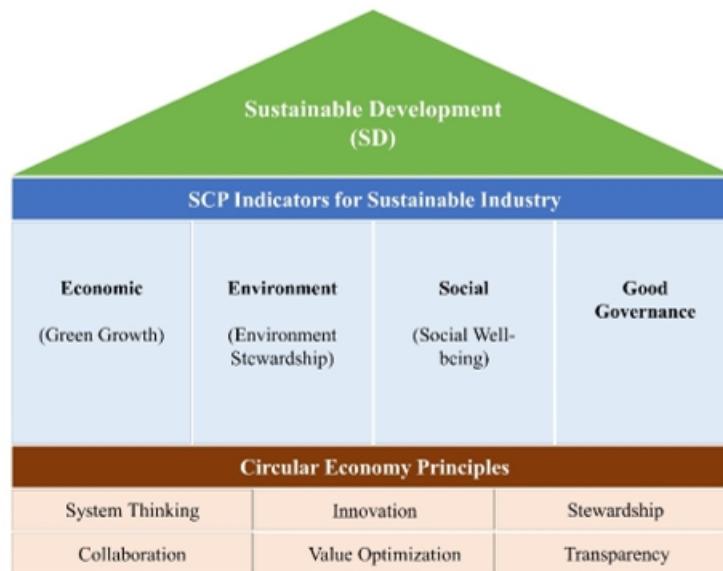
4. Good governance indicators. The code of conduct for mission statement sub-indicator should be added in the corporate ethics indicators.

To sum up, 6 sub-indicators of the 1<sup>st</sup> draft were deleted. The 2<sup>nd</sup> draft of SCP indicators consisted of 28 sets of indicators and 72 sub-indicators.

#### 5.3 Finalization of SCP Indicators.

The 3<sup>rd</sup> draft of SCP indicators was developed and verified by the 5 activities described in 4.3. From those activities the industries' opinions on obstacles of implementing the SD indicators complied with the experts, the Eco Factory working group, and public sectors. Regarding the obstacles of implementing the indicators based on the 14 Eco Factory criteria, the experts claimed that there were obstacles to 11 criteria for implementing the indicators (such as biodiversity, materials management and green supply chain, green landscape management), which was consistent to most stakeholders. The obstacles to the implementation based on the same criteria were mentioned by both the experts and the industry. The specified obstacles are significant as the industrial entrepreneurs who gave opinions towards the improvement are in the manufacturing companies in the large-scale upstream industries that utilize the intense and modern production technology with readiness of human resources and capitals. Moreover, some of them have conducted the report based on the GRI international sustainability reporting and they are in the DJSI List. Thus, the obstacles are mainly on Eco Factory criteria.

All comments and suggestions were taken into consideration to improve the indicators. In summary, the



**Figure 1:** The conceptual framework of SCP indicator development for sustainable development for Thai industries [9–11].

final version of SCP indicators for sustainable development for Thai industries consisted of 4 dimensions (26 sets of indicators, 60 sub-indicators) as follows:

1. Environmental dimension (11 sets of indicators, 32 sub-indicators): These indicators corresponded to the indicators in the SCP Roadmap on 5 out of 8 goals for manufacturing sectors, CE principle, system thinking, innovation, value optimization, and stewardship in terms of indicator operation by covering life cycle thinking, impacts of product life cycle, efficiency of resource consumption, intensity renewable materials and renewable energy, hazardous material, % symbiosis, waste and wastewater, energy intensity, greenhouse gas management, logistics, technology, and supplier.

2. Social dimension (4 sets of indicators, 11 sub-indicators): These indicators expressed the social responsibility of the organization that reflected the sustainable responsibility to stakeholders in all dimensions as well as the creation of collaboration, stewardship and transparency for worker, customers, consumers, communities, and employees based on the CE principles.

3. Economic dimension (5 sets of indicators, 9 sub-indicators): These indicators could track the economic sustainability of the organization, which were revenues and profits, employment expense, environmental expense, investment on research and development, eco-innovation, technology transfer and machine usage efficiency, green procurement, and local procurement.

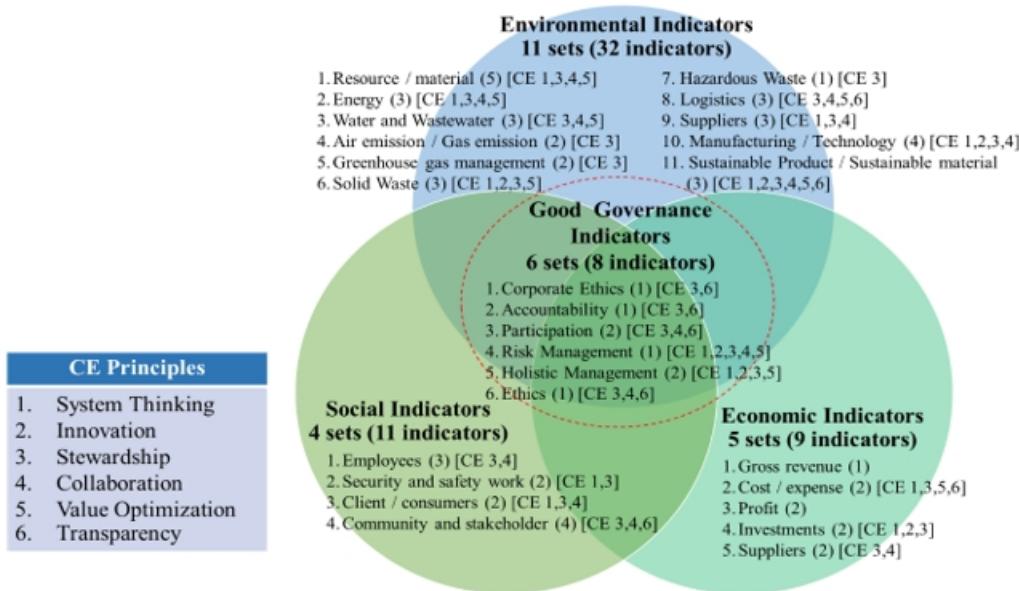
4. Good governance dimension (6 sets of indicators, 8 sub-indicators): These indicators strengthened sustainable development of the organization with the indicators of corporate ethics, ethical behavior, accountability, sustainable risk management action plan,

holistic management and participation. Furthermore, these indicators helped tracking whether the operation of the organization was sustainable and efficient. Figure 2 showed the final version of SCP indicators in 4 dimensions.

The number of set indicators was equal to other studies recommending for the industrial sustainable development [12]. The important perspectives of stakeholders towards the sustainable development framework emphasized on environmental issues and gave higher weight on economic indicators in eco-efficiency than other indicators, such as indicators of technology and production equipment investment efficiency, or social indicators. The sustainable development needed to create balance in all dimensions simultaneously; therefore, there should be sufficient indicators to monitor and evaluate the sustainable development progress in short term, medium term, and long term[16].

## 6. Conclusions

The research reviewed literature on the development of SD indicators for industrial sector and the accepted SD indicator standards, such as the international academic studies, Eco Factory criteria, the SCP Roadmap, and the CE principle. The indicators development in this research employed 3 surveys of stakeholders including target industries, Eco Factory working group, related government agencies and experts. In addition, the in-depth interview was conducted on industries, and the focus group meeting was conducted on the experts and governments officers who are responsible for Eco Industrial Town Promotion. The limitation of this research is that its target industries who participated in the study were mainly



**Figure 2:** Sustainable consumption and production indicators for industrial sector according to circular economy principles in Thailand.

**Table 1.** The final sets of SCP indicators are consistent with CE and can be identified according to the 6 CE principles as follows.

CE Principles	Environmental	Social	Economic	Good Governance	Total
System Thinking	6	2	2	2	12
Innovation	3	n/a	1	2	6
Stewardship	11	4	3	6	24
Collaboration	7	3	1	4	15
Value optimization	6	n/a	1	2	9
Transparency	2	1	1	4	8

the large-scale group, while there was only one small and medium scale.

From this research, the 26 sets of indicators with 60 sub-indicators were developed, and these indicators could be categorized by dimension as follows:

1. Environmental dimension having 11 sets of indicators with 32 sub-indicators
2. Social dimension having 4 sets of indicators with 11 sub-indicators
3. Economic dimension having 5 sets of indicators with 9 sub-indicators
4. Good governance dimension having 6 sets of indicators with 8 sub-indicators

The benefits of the indicators are reduction of resource expense and promotion of positive image to communities and customers who could create more systematic development plans, and environmental resource, and emission management goals. The set of SCP indicators would be able to enhance Thai Industries to monitor and assess their sustainable level consistent to the SCP Roadmap and the BCG policy. This can also strengthen the transition of their future business models into the circular economy.

## 7. Recommendations for Implementation of the Indicators

7.1. There should be a pilot project to support practical implementation in the industrial sector based on the industrial types including upstream, middle-stream, and downstream industries or based on the industrial sizes including large-, medium-, and small-scale industries. This is due to the differences of readiness conditions in implementing the indicators, such as the environment of the upstream, middle-stream, and downstream industries, or technology utilization, resources, employees, market, and investment.

7.2. There should be periodic reviews of the indicators, such as every 3 years by entrepreneurs and other sectors. Moreover, there should be standards, evaluation, and certification based on the circular economy standard of Thai Industrial Standard Institute (TISI).

7.3. There should be a consideration on supporting the information provision and workshops at the first step to promote the readiness for the industries who are interested in implementing the indicators. In addition, there should be supports to the sustainability reporting of indicator implementation and creation of collaboration network between large-scale industries with the readiness in conducting the sustainable development and being a mentor in supporting the medium-

and small-scale industries who lack of readiness on the issue.

### Acknowledgments

The authors would like to acknowledge great supports from the Graduate School of Environmental Development Administration of the National Institute of Development Administration, the Water and Environment Institute for Sustainability, the Federation of Thai Industries, the Eco Factory Working Group member, and the Thai Sustainable Consumption and Production Network and Community Partnership Association. Our special thanks also go to all research participants both the representatives from industries and the experts for their contribution to this study.

### References

- [1] Office of the National Economic and Social Development Board (2016). Summary the Eleventh National Economic and Social Development Plan (2012–2016). Bangkok: National Economic and Social Development Board.
- [2] Office of the National Economic and Social Development Board (2017). Summary The Twelfth National Economic and Social Development Plan (2017–2021). Bangkok: Office of the National Economic and Social Development Board.
- [3] National Science and Technology Development Agency (n.d.). BCG Economy Model. <https://www.nstda.or.th/nstda-strategy-plan/nstda2/12785-bcg-economy>.
- [4] Office of Natural Resource and Environmental Policy and Planning (ONEP) (2017). Sustainable Consumption and Production Roadmap 2017–2036 (SCP Roadmap 2017–2036): Office of Natural Resource and Environmental Policy and Planning (ONEP).
- [5] Office of Natural Resource and Environmental Policy and Planning (ONEP) (2020). Sustainable Consumption and Production Roadmap 2017–2037 (Revised Version 1). Thammasat University Research and Consultancy Institute: Office of Natural Resource and Environmental Policy and Planning (ONEP).
- [6] Federation of Thai Industries and Industrial Estate Authority of Thailand (2018). Manual of Eco Factory Requirements.
- [7] T. Waas, J. Hugé, T. Block, T. Wright, F. Benitez-Capistrós, A. Verbruggen, Sustainability Assessment and Indicators: Tools in a Decision-Making Strategy for Sustainable Development. *Sustainability* 6 (2014) 5512–5534. doi:10.3390/su6095512.
- [8] Thailand Textile Institute. *Thai Textile Statistics 2018/2019*. Bangkok: Thailand Textile Institute, 2019.
- [9] C. Joung, J. Carrell, P. Sarkar, S. Feng, Categorization of Indicators for Sustainable Manufacturing. *Ecological Indicators* 24 (2013) 148–157. doi:10.1016/j.ecolind.2012.05.030
- [10] British Standards Institution. Framework for Implementing the Principles of the Circular Economy in Organizations—Guide. BSI Standards Publication: BSI Standards Limited, 2017.
- [11] N. Scialabba, SAFA Guidelines. *Sustainability Assessment of Food And Agriculture Systems*. Version 3.0, 2013.
- [12] A. Feil, D. Schreiber, C. Haetinger, V. Strasburg, C. Barkert, Sustainability Indicators for Industrial Organizations: Systematic Review of Literature. *Sustainability* 11 (2019) 854. doi:10.3390/su11030854.
- [13] M. Winroth, P. Almström, C. Andersson, Sustainable Indicators at Factory Level—A Framework for Practical Assessment, 2012.
- [14] G. Eseoglu, Ö. Vayvay, Z. Kalender, Assessment of Sustainability Performance Indicators in Manufacturing, 2014.
- [15] Global Reporting Initiative. G4 Sustainability Reporting Guidelines: Reporting Principles and Standard Disclosures: Reporting Principles and Standard Disclosures, 2015.
- [16] I. Garbie, Sustainable Development Index on Macro-Level in Industrial Estates and Specialised Sectors. *International Journal of Industrial and Systems Engineering* 24 (2016) 384. doi:10.1504/IJISE.2016.10000247.