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A study on ecolabeling and Life Cycle Assessment for food products in Indonesia: Potential application to improve the competitiveness of the tea industry

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Abstract. The increasing customer awareness and supporting regulation on environmentally-friendly products around the globe has fostered the need for revealing environmental performance information on their label, using an instrument called ecolabel. Ecolabeling system requires a life cycle consideration for the product, and Life Cycle Assessment (LCA) serves as a method to perform the assessment for the entire product's life cycle. In the field of food industry, specifically the tea industry, a 2014 report by International Institute for Sustainable Development showed a growing influence of ecolabel in the global market. Ecolabel and LCA become important tools for improving product competitiveness. Meanwhile, tea as one of Indonesia's main commodity has faced a challenging competition in the international market as indicated by decreasing export—despite increasing global demand—in recent year. This study reviews the ecolabeling system in Indonesia and LCA for food products. Furthermore, this study also investigates the potential application of ecolabel and LCA to improve the competitiveness of the tea industry. According to the study, the implementation of ecolabeling for tea still faces some challenging issues due to the supporting certification scheme and customer perspective. On the contrary, research on LCA for food products provides a promising application to improve tea product competitiveness. Therefore, this study recommended that, while educating people more toward ecolabeling, research on LCA should be continuously conducted to support the implementation of ecolabel in the long term.

1. Introduction

The concept and implementation of ecolabeling have been growing to reflect global concern for environmental protection. Environmental product information has emerged in various term such as natural, eco-friendly, low energy, recyclable, etc.

"Ecolabeling" is a voluntary tool of environmental product performance certification and labelling. The labels should be awarded by an independent third-party for specific products or services that meet environmental criteria, based on life-cycle considerations [1].



Not all environmental labelling can be defined as ecolabels. An ecolabel is a label that identifies the overall environmental preference of a product or service based on life cycle considerations [2]. The term “life cycle considerations” means that ecolabel considers the impact on the environment throughout the product’s life cycle, from extraction or resources, design, production, distribution, use, up to disposal. Thus, life cycle assessment (LCA) is used to consider the impact of e.g. greenhouse gas emissions, water use, air pollution, use of non-renewable resources, chemical emissions and waste amounts [2].

Program related to ecolabel can be traced back and has been implemented in many countries (with different terms), such as 1977 in Germany (Blue Angel), 1988 in Canada (Environmental Choice), 1989 in Japan (Eco Mark), 1990 in US (Green Seal), 1991 in India (Eco-Mark), and 1993 in European Union (Eco-label) [3]. Indonesia has started to implement ecolabel in 2004 to improve the competitiveness of product in international trade [4].

Indonesia has been historically known as one of tea producing countries in the world. The country’s major export destination countries are Russia, Malaysia, Germany, USA and Pakistan (Figure 1). However, the country’s tea production tends to be decreasing in term of quantity and quality [5]. Consequently, tea as one of Indonesia’s main commodity has faced a challenging competition in the international market as indicated by a decreasing export despite increasing global demand at an average rate of 0.6% a year [6].



Figure 1. Destination countries for exporting Indonesian tea in 2016 (volume in ton) [7].

With the increasing challenge in the global market, as well as growing awareness of environmental protection, Indonesian tea will need to adapt to the challenges to remain competitive. Therefore, a study on the potential application of ecolabel and LCA for tea product competitiveness should be addressed equally.

2. Research purpose

This research aims to study ecolabeling and life cycle assessment for food products in Indonesia, and its potential application to the tea industry. Specifically, it will discuss the potential application by considering government regulation, industrial application, and customer perspective toward sustainability issue.

The output of this study is expected to provide fundamental insight into the importance of ecolabel and LCA to improve the competitiveness of Indonesian food product trade in the international market by considering environmental protection. In particular, the output can be utilized to stimulate further study related to ecolabel and LCA of tea industry for sustainable production and consumption.

3. Methods

This study was performed based on desk review toward a number of literature related to ecolabeling and LCA for food products in Indonesia. The literature for review (data collection) was gathered from various and recent sources such as scientific articles, government regulation, handbook and mass media

information. The scientific articles for the study were taken from international and national publication, particularly within the latest five years.

Based on the review, the analysis was performed to evaluate the potential application of ecolabel and LCA to the tea industry. The analysis reviewed the theoretical framework of ecolabel and LCA, and then explored their potential implementation by considering global practice and consumer perspective toward ecolabel and sustainability issue. Figure 2 illustrated further the research framework for this study.

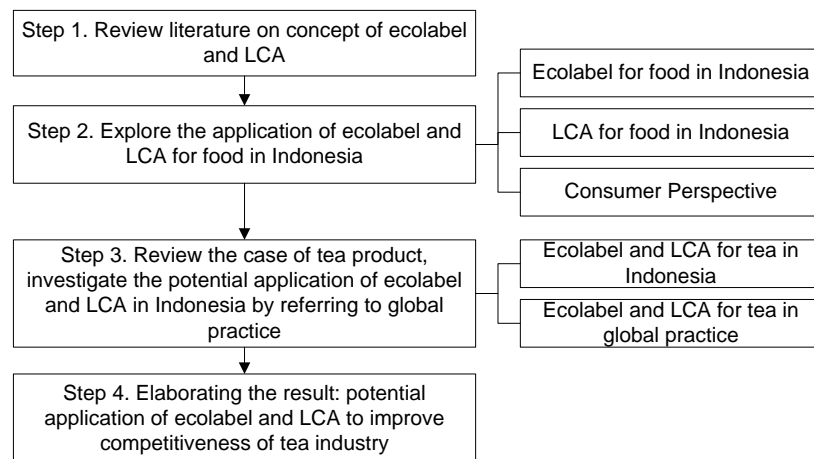


Figure 2. Research framework used in this study.

4. Result and discussion

4.1. Ecolabeling in Indonesia

The International Organization for Standardization (ISO) has defined three kinds of environmental labels as follows [8].

- Type I (ISO 14024): a voluntary, multiple-criteria based third-party programme that awards a license which authorizes the use of environmental labels on products indicating overall environmental preferability of a product within a particular product category based on life cycle considerations
- Type II (ISO 14021): informative environmental *self-declaration* claims, that is made, without independent third-party certification, by manufacturers, importers, distributors, retailers or anyone else likely to benefit from such a claim. The ISO standard lists several requirements for these claims such as accuracy, possibilities for verification and consideration of relevant environmental aspects. Accordingly, vague or non-specific claims (“eco-friendly”, “green”, “non-polluting”...) should also be avoided.
- Type III: environmental declaration with environmental data quantification using ISO 14040 and 14044

These three label types of ISO have common goals, i.e. to encourage the demand and supply of sustainable products and services through communication of verifiable and accurate information on environmental aspects that is not misleading, hence, the labels can stimulate potential for market-driven continuous environmental improvement [9].

Under ISO 14020 series, environmental labels and the environmental product declarations (particularly ISO type III) can be indicated through the simple presence of a specific logo or by an LCA-based declaration. This will allow people to recognize the environmental sustainability of a product or service [10].

Ecolabel has been initiated in Indonesia in 1994 by a working group on Ecolabel, formed by the Indonesian Ministry of Forestry. This working group was working on the development of criteria and indicator for sustainable forest management, which later lead to the establishment of The Indonesian Ecolabelling Institute (LEI) in 1998 [11].

The Indonesian ecolabel logo and scheme were issued by the Indonesian Ministry of Environment and the National Standardization Agency of Indonesia on the commemoration of the World Environment Day on June 5, 2004, in Jakarta [12]. The tools for implementing ecolabel certification are prepared by the Ministry of Environment in collaboration with the National Accreditation Committee, related technical agencies, certification institutions, testing laboratories and other parties until the end of 2004.

In 2009, the President of The Republic of Indonesia has issued a law, entitled Undang-Undang No. 32 Tahun 2009 about the environment protection and management, which specified the environmentally-friendly label for products [13]. This regulation was then derived in 2014 by the Indonesian Ministry of Environment by issuing an act on the inclusion of the ecolabel logo, namely Peraturan Menteri Lingkungan Hidup Nomor 2 Tahun 2014 [14]. In this regulation, the ministry introduced two types of ecolabel, referred to as “Ekolabel” (Figure 3):

- Type I: Logo Ekolabel Indonesia (Indonesian Ecolabel Logo), is a logo awarded to a product which has been certified by the ecolabel certification body.
- Type II: Logo Ekolabel Swadeklarasi Indonesia (Indonesian Self-declaration Ecolabel Logo), a logo awarded to a product based on verification by ecolabel verification body on a claim by the producer, importer, distributor, retailer, copyright owner or others.



(a)



(b)

Figure 3. Ekolabel logo of Indonesia: (a) Type I, (b) Type II.

Currently, Indonesia has developed ecolabel criteria for 14 types of product category, including detergent, leather, shoes, paper product, carbon zinc and alkaline based battery, furniture, plastic bag, etc. However, there are still a few companies applying as ecolabel certifying body in Indonesia. The National Standardization Agency on Indonesia listed two companies as ecolabel certification bodies (LSE) (Table 1). Meanwhile, the Indonesian Ministry of Environment and Forestry has registered three ecolabel verification bodies (LVE) (Table 2). Neither LSE nor LVE has a scope of ecolabeling on the food sectors, hence, the food industry could not obtain ecolabel certification using the logo of Indonesia at present.

Table 1. List of Ecolabel Certification Body (LSE) in Indonesia [15].

No.	Name	Address	Reg ID (No.LPK)	Scope
1	Mutuagung Lestari (MALECO), PT	Jl. Raya Bogor Km. 33,5 No. 19, Cimanggis, Bogor	LSE-001-IDN	Sanitary tissues, printing papers, textiles
2	PaPICS Balai Besar Pulp dan Kertas	Jl. Raya Dayeuh Kolot 132, Bandung	LSE-002-IDN	Packaging papers, printing papers, wall paints, plastic bags

Table 2. List of Ecolabel Verification Body (LVE) in Indonesia [16].

No.	Name	Address	Scope
1	PaPICS Balai Besar Pulp dan Kertas	Jl. Raya Dayeuh Kolot 132, Bandung	Papers, plastics
2	Garuda Sertifikasi Indonesia, PT	Jl. Pidada XI No. 9X Gatot Subroto Denpasar – Bali	Services (hotel, resort, villa)
3	Mutuagung Lestari (MALECO), PT	Jl. Raya Bogor Km. 33,5 No. 19, Cimanggis, Bogor	Clothes, batik fabrics, traditional woven fabrics

Ecolabel has been used by a number of industrial sectors in Indonesia. In the forestry sector, for instance, ecolabel is claimed to be used by around 300 industries in Indonesia, covering 2.7 million ha of forest area [17]. These industries mostly obtained ecolabel certification scheme by third-parties linked to overseas. Meanwhile, in the other sectors, there are also about 20 products using ecolabel logo of Indonesia type II as recorded by the Indonesian Ministry of Environment and Forestry [18]. These industries mainly came from plastics, papers and foods sectors. Despite various sectors of industry implementing ecolabel, the application for the food sector has not been found directly. It may indirectly occur in agricultural sector related to forestry, but further investigation is still required.

4.2. Life Cycle Assessment for food products in Indonesia

A study of research on Life Cycle Assessment published in an international indexed journal has shown that the research on LCA has been conducted in Indonesia since 1996, and increasing significantly after 2010 [19]. Interestingly, among these researches, there were also publications of LCA for food products such as sugarcane, rice, fish, and milk.

Further investigation to some national publications in the last five years revealed that there were also a number of researches working on LCA of food products (Table 3). These researches have shown the potential application of LCA to obtain better performances of the products. In addition, research on LCA for tea industries has also been conducted in Indonesia, implying the increasing attention toward product competitiveness of tea in the global market.

According to literature in Table 3, the main results show that LCA can be used to evaluate the environmental performance of food products. The impacts used in these studies vary, such as energy consumption, gas emission (CO₂, CH₄, N₂O, CO, SO₂, and NO_x), particle pollutants etc. The data is mainly collected from related food factories. The tools for calculation are primarily LCA supported with others like ANP and LCC. Some of the researches use software like SimaPro to support the study, while the others calculate manually.

While enormous effort has been performed toward research on LCA, none of them was related directly to the ecolabel system. Most studies are mainly to improve production system performance with no results leads to ecolabel recommendation. This mainly possibly due to no infrastructure at present (policy, program, scheme) to accommodate this application. However, these positive trends on the research indicate the good methodological contribution of LCA in Indonesia to support the ecolabel system in the future.

4.3. Consumer perspective toward ecolabel and sustainability issues

Nadlifatin et. al. (2016) studied Indonesian citizens' intentions toward ecolabel product usage based on behavior theory [36]. The study used 213 respondents of 47 cities and regencies in Indonesia and showed that attitude was a key determinant factor influencing the citizens regarding ecolabel product usage. In addition, government and related agencies should persuade companies to produce more eco-products, while companies should highlight the ecolabel image to their benefit.

Table 3. Example of LCA implementation for various food products in Indonesia.

Food Product	Description	Impact indicator	Data	Tools
Gudeg canning [20]	Gudeg is a traditional Javanese cuisine made from young unripe jack fruit (Javanese: gori). The scope of the research included 4 sub-systems: raw material procurement, cooking, canning, and packaging	Energy consumption, Gas emission (CO ₂ , CH ₄ , N ₂ O, CO, SO ₂ , and NO _x)	Gudeg SME in Yogyakarta	LCA and Life Cycle Costing (LCC)
Food bakery [21]	The purpose of the study was to assess the environmental impact of the bread production company and compare with an alternative process.	Cumulated impact points	Bakery SME	LCA and Analytic Network Process (ANP) with software SimaPro and SuperDecision
Instant noodle packaging [22]	The research evaluated the potential environmental impact of instant noodle in 80 gr cup and compared three popular brands.	Cumulated impact points	Noodle packaging of three popular brands	LCA with SimaPro software
Rice [23]	The analysis of LCA was performed to investigate the environmental impact, net energy value and net energy ratio of rice production.	Energy consumption and CO ₂ emission	Rice production center in West Java	LCA
Dairy product [24]	Dairy farm and its supply chain were evaluated with LCA, and the improvement was proposed using Analytic Network Process	Cumulated impact points	Dairy cooperation in Malang	LCA and ANP with SimaPro software
Isotonic Drink [25]	This study aimed to identify the environmental impacts caused by the production process and waste treatment process of a popular brand isotonic drink product.	Cumulated impact points	National bottled drinking company in Central Java	LCA with SimaPro Software
Sugar cane [26]	Life cycle analysis of the sugar production process including raw materials and energy in order to determine the efficiency of production and environmental impact.	Energy consumption, gas emission (NO _x , SO _x)	Sugar company in West Java	LCA with SimaPro Software
PET Drinking Bottle [27]	This life-cycle assessment in the study includes production process, inventory, environmental impact, and cost analysis of tea beverage product.	GWP, reduced ozone layer, acid rain	Tea drinking bottle industry	LCA and cost analysis
Glass Drinking Bottle [28]	The study aims to conduct life cycle assessment (LCA) of glass bottle, environmental impact assessment, and recycling cost analysis, by using case of tea product.	GWP, reduced ozone layer, acid rain	Tea drinking bottle industry	LCA and cost analysis
Fish product [29]	The research evaluated the effects of fish processing on the environment, using samples of fresh fish, fried fish and barbequed fish.	Energy consumption, gas emission (CO ₂ , SO ₂ , NO _x) and particle pollutant	Fish market in Yogyakarta	LCA
Chicken noodle [30]	LCA and LCC were conducted to calculate the energy consumed and life cycle costing of chicken noodle on various services scale.	Energy consumption and cost analysis	Chicken noodle catering	LCA and LCC
Tofu [31–33]	By using LCA to analyze tofu production system, some improvements have been recommended to reduce the energy consumption and greenhouse gas emission	Energy consumption, carbon footprint	Tofu industries in Banyumas [31], Pati [32] and Tangerang Selatan [33]	LCA
Tea [34,35]	The studies implement LCA of tea, starting from tea plantation to manufacture [34] and from plantation to distribution [35].	Energy consumption, GWP, AP, EP	Tea factories in Yogyakarta	LCA

A study by Putri and Anityasari (2012) found further regarding sustainable life style of students in Surabaya City [37]. Sustainable life style refers to the life style which considers sustainability perspective in their daily life. Their findings suggest that since the understanding on the sustainable life style of students was still low, more education approaches should be introduced, such as through practical guideline, education curriculum, training, ecological footprint calculator and mass media socialization.

Specific analysis on customer attitude toward ecolabeling was researched by Giyatno and Sumarsono (2013) [38]. Environmental information claims on detergent's label and symbol were used as the subject of studies, such as free of dangerous substance, biodegradable content, recycle material, etc. The study indicated that the customer's knowledge toward environmental information on the product's label was low, hence, a more serious effort to educate customer was encouraged. The study also showed that customer attitude toward buying decision of product was mainly determined by price, quality and product's advantage, with little consideration to environmental benefit. However, when it came to the product usage, the customer had a positive attitude toward the environment, by using the product efficiently, buying the product in large size and throwing the garbage into the bin.

4.4. Overview of the tea production system and its improvement through implementation of LCA and ecolabel

Indonesia produces different types of tea such as black tea, green tea, oolong tea and white tea, but the popular ones are black tea and green tea [34]. The production process of both types of tea are typically similar except black tea uses a fermentation process. The production system starts from tea plantation on farm followed with tea manufacturing at plant and distribution. The overall process of the tea life cycle can be depicted in Figure 4.

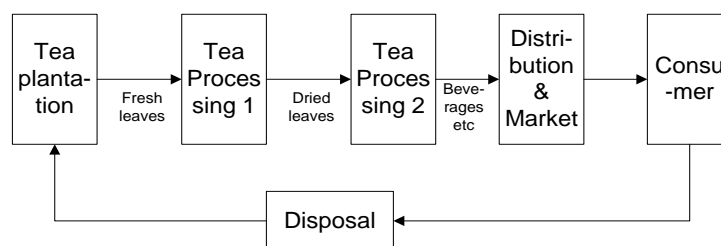


Figure 4. The life cycle of tea.

The activities of tea plantation on farm consist of land cultivation, tea seeding and growing, replanting and harvesting. To do these, a number of inputs are required, such as fertilizer, pesticide, compost and energy (electricity, diesel or petrol for machinery and transportation) [39]. Fresh tea leaves are harvested regularly as the main output from these activities and delivered to the plant.

At the plant, the fresh tea leaves are processed through activities such as withering, steaming, rolling and shaping or drying. These activities generally involve machinery with electricity or energy from LPG or pellet as inputs. The main output is dried tea leaves and the releases are wood ash, tea fluff and emission such as CO₂ [40].

The output of dried tea leaves may be packed in bulk to be processed further by other factories. The factories combine the tea with other formula to produce tea drink in bottles, cans, packs, sachets etc.

A number of studies have been performed using a Life Cycle Assessment to improve tea production at various life cycle stages by considering the environment. At farm plantation, for instance from Cichorowski's study, it can be inferred that using urea doubled the global warming potential compared to compost as a nitrogen source [41]. While in the production plant, packaging can be considered as the environmental hot spot in a life cycle study [42], hence, appropriate material selection and packaging size should be considered in the early product design.



Figure 5. Ecolabel of commercial tea products [43,44].

The result of LCA study can be displayed in the form of ecolabel using an indicator such as carbon footprint on the packaging material. Figure 5 illustrates the use of this ecolabel on the green tea bottle in Taiwan to maintain product competitiveness.

4.5. Elaboration: Potential application of ecolabel and LCA to improve the competitiveness of the tea industry

In Europe, more than 54,000 products and services categorized into different types have carried the EU Ecolabel [45]. The category diverges into more than 30 types such as rinse and cosmetics product, laundry detergent, cleaning services, shoes, textiles, computers, televisions, paper products, furniture, tourist accommodation, etc [46]. The commission has also conducted a study on the feasibility of developing Ecolabel criteria for food and feed products. Tea industry was included within the scope of the study. Along with the opinion of the European Union Ecolabelling Board, the commission concluded that ecolabel for this category has not been recommended in the near future. There are many issues to be considered for this category, such as ethics, social and consumer preference on the organic certification. Interestingly the study also mentioned that dairy, bread, non-alcoholic beverages (including tea) and processed fish products are likely to become suitable in the early phase of introducing an EU Ecolabel for food [47]. A report entitled “Development of the EU Ecolabel criteria for food retail stores” has also been published for the development of future EU Ecolabel for supermarket [48].

Current trends on ecolabel show that positive step has been initiated for the food industry, starting from the market store. Particularly, the use of LCA and ecolabel for tea product globally have also been implemented. As Indonesian food product including tea has been entering the international market, the application of ecolabel and LCA should also be addressed to make the product more competitive, not only in local but also in global trade.

According to the review, the implementation of ecolabeling for tea in Indonesia encounters some challenging issues due to supporting certification scheme and customer perspective. On the contrary, research on LCA for food products provides a promising application to improve product competitiveness, including for tea. Therefore, while educating people more toward ecolabeling, research on LCA should be continuously conducted to support the implementation of ecolabel in the long term. Further, research on LCA and ecolabel should be integrated with technology assessment [49] and technology transfer such as using efficient approach [50] in order to accelerate the dissemination and implementation in the communities.

5. Concluding remarks

Ecolabeling schemes as tools for presenting environmental information of a product to customer offer a promising tool to improve product competitiveness. This is supported by the application of ecolabel of food products in the other countries supported with prepared regulation of EU food ecolabel. In Indonesia, however, the study shows that ecolabeling system has been implemented mainly for paper, plastics and papers, but it still has not been implemented for the food industry. The limited scope of

certification scheme and customer perspective toward ecolabeling hamper its implementation in near future.

Despite its challenging issue on ecolabeling, the potential application of Life Cycle Assessment for food is more promising. Many studies have been conducted in Indonesia to implement Life Cycle Assessment on food products. Specifically for tea, LCA can be performed to improve tea in its entire life cycle, from tea plantation, processing, distribution, consumption and disposal. Therefore, this study recommends that, while educating people more toward ecolabeling, research on LCA should be conducted to support the implementation of ecolabel in the long term.

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