Life Cycle Assessment Framework Application in Malaysia

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Abstract. Life cycle assessment (LCA) is broadly used around the world. The comprehensiveness of the method helps to avoid problem-shifter in reducing environmental impact from anthropogenic activities. In Southeast Asia, some countries have adopted gradually the application of life cycle approach in government action plans and marketing strategies. However, its progress remains unclear due to the lack of investigative studies. The aim of this paper is to provide a review of the current application of LCA framework in Malaysia. The paper also highlights the acceptance of the concept within government sectors and industrial players. The life cycle assessment (LCA) Progress in Malaysia can be seen from three perspectives: 1) government planning and policy; 2) industry involvement and 3) LCA priorities. This study reviewed the current progress of LCA implementation in Malaysia based on the current literature. In government planning and policy, LCA has been embedded in project development and monitoring through the Carbon Reduction Initiative and National Database Development. However, the progress in industry involvement so far has shown less participation due to low demand towards green products. In moving towards a high-income nation and open economy, the Malaysian government has emphasized on the need for greater inclusiveness where green initiatives were put forward in Malaysia’s development.

Keywords: Life Cycle Assessment; Policy; Environmental Management; Sustainability

1.0 Introduction

Life cycle assessment (LCA) is a holistic approach to evaluate environmental sustainability of any process/product throughout its life cycle [1]. The concept is based on precautionary principle, the evaluations on environmental impacts in LCA shows the potential impacts from system boundary rather than physical pollution level. In terms of LCA platforms, developed regions such as European Union (EU) put an effort to develop and improvise LCA framework and they applied it in government initiatives as well as for market exposures. This is due to method maturity as well as green market acceptance in these areas. In developing countries, the concept of LCA is gradually accepted where the approach is being considered in government action plan in moving towards sustainability. In Malaysia, the LCA is gradually growing and being practiced among academic and industrial circles [2]. However, only a few literatures are showing the progress of LCA in these countries such as Malaysia. Thus this study aims to highlight the life cycle assessment (LCA) exposures in a developing country in which the case study is on Malaysia. The study gives the LCA progress in Malaysia as reference to enlighten future policy.

2.1 LCA-related Activities in Malaysia

The life cycle progress in Malaysia can be seen from three perspectives 1) Government planning; 2) Industry involvement and 3) LCA priorities in Malaysia. The next discussion on the sector will be based on these three perspectives.

Life cycle concept has been embedded government policies regarding product and service to achieve sustainable development as seen in strategic planning in pursuing green growth resilience [2].
One of the goals is to adopt the sustainable consumption and production concept (SCP). The SCP concept has been harmonized in National Green Technology Policy to introduce the community with low carbon environment concept. In line with policy implementation, Malaysia has established National Green Technology Master Plan (GTMP) to promote green culture where life cycle assessment LCA has play a vital role. The SCP concerns with two critical elements: carbon reduction and national database development. Carbon reduction initiative or quantification of greenhouse gas emissions per GDP is generally part of LCA methodology that focuses on global warming and climate change. Globally, various initiatives have been taken to reduce carbon emission to alleviate the present and future global warming occurrence. In 2015, a voluntary carbon reporting programme namely MyCarbon Reporting Programme had shown participation of 26 companies in Malaysia [2]. In 2013, the programme has initiated organizational effort to evaluate their Greenhouse Gasses (GHGs) emissions and to identify mitigation steps for reducing their carbon emissions. In line with national carbon reporting programme, few initiatives were established by various approaches through institutional framework, policies and regulation, fiscal instrument, labelling and certification, rating tool and green township. The carbon reduction resolution in Malaysia was issued by Malaysian Green Technology Corporation (GreenTech Malaysia) and Yayasan Hijau Malaysia (YaHijau). The Malaysia’s Ministry of Energy, Green Technology and Water (KETTHA) or currently Kementerian Alam Sekitar dan Air (KASA); and Green Tech Malaysia or currently known as Malaysian Green Technology and Climate Change Centre are promoting green technology development aligned with National Green Technology Policy 2009 for socio-economic growth in Malaysia [3]. Based on four key flagship projects namely green Malaysia plan, green procurement, sustainable living and electric mobility; the institute covers five critical sectors in Malaysia: transport, energy, waste management, building, and water management.

In case of labelling and certification, a policy is introduced under MyHIJAU programme with the objective to bring together certified product and service that comply with international standard [4]. Based on life cycle approach, the scheme provides a platform to support the national initiatives as well as one of the main key drivers of environmental management concepts [5]. The program includes eco-labelling, energy efficiency rating, labelling scheme and water efficient products labelling scheme. The eco-labelling in Malaysia was introduced in 1992 after the formation of a National Advisory Committee on eco-labelling under the national standard infrastructure by Standard and Industrial Research Institute of Malaysia (SIRIM) [6]. SIRIM is an industrial research and technological organization that has played a major role in the development of Malaysia’s private sector, such as standards development platforms [7]. The Environmental Technology Research Centre (ETRC) of SIRIM Berhad has continued to develop 41 SIRIM eco-labelling criteria for various product [8]. Under Malaysia’s plan in adopting the sustainable consumption and production (SCP) concept (SCP), SIRIM was funded by International grant under the EU Switch-Asia Programme. It has developed 13 Product Criteria Rules (PCRs) for construction material [8]. In collaboration with federation of Malaysian manufacturers (FMM), Malaysia Green Building Confederation (MGBC), Carbon Trust UK, Building Materials Distributors Association of Malaysia (BMDAM) and SIRIM QAS International Sdn. Bhd. (SQAS) have awarded ten small and medium-sized enterprises (SMEs) and eight companies for obtaining the first CFP certification by SQAS. With the support of Performance Management and Delivery Unit (PEMANDU), an eco-innovation facility was developed to enhance life cycle approach in product design as well as LCA training. Particularly, in lifting the electrical and electronic sector under the National Key Economic Areas (NKEA) initiatives. The eco-labelling covers various categories, such as lightings, personal care products, household products and building materials. In 10th Malaysia’s Plan, 73 eco-label licences were issued to industry player in Malaysia from various sectors, such as personal care, construction, steel industry and electrical appliances [2]. The programme has successfully attracted huge interest among various organizations in Malaysia. In 2017, there are three types of environmental labels and declarations as governed by ISO 14020s [7]. They are as follows:
ISO 14024: Environmental labels and declarations – Type I environmental labelling – Principles and procedures.

ISO 14021: Environmental labels and declarations – Type II environmental labelling - Self-declared environmental claims

ISO 14025: Environmental labels and declarations – Type III environmental declarations – Principles and procedures

Some indicators such as Low Carbon City Framework (LCCF) and assessment tools were also used as guidelines for carbon reduction initiatives. The main target is to promote reduction of carbon emission in urban areas. The carbon emissions in cities are a result of high energy consumption. Based on carbon footprint methodology, four fundamentals sectors namely urban environment, urban transportation, urban infrastructure and buildings were included to evaluate the performance criteria [9]. Under these sectors, 13 performance criteria will be assessed such as green vehicles, waste, energy, water and low carbon building. Aligned with the indicators, rating tools such as Green Building Index (GBI), Green PASS, Malaysian Carbon Reduction and Environmental Sustainable Tool (MyCREST) were implemented [10]. The GBI is Malaysia’s first building evaluation in term of environmental design and performance which is based on six criteria namely energy efficiency, indoor environment quality, sustainable site planning & management, materials & resources, water efficiency, and innovation [11]. Until 2014, the programme has managed to certify 334 buildings in Malaysia reducing 0.73 Mt-CO₂eq of emission by GBI certified buildings [12]. Green PASS certification on the other hand, is purely based on carbon emission assessment for buildings construction and operations [10]. Another certification, MyCREST has broader scope that includes sustainable element [13]. Integrating both carbon quantification and sustainable performance factor, the scheme provides holistic sustainable rating system based on life cycle–linked performances and continuity of Green PASS certification. In contrast with National GHG reduction programme (MyCarbon) that only covers operational carbon, MyCREST includes building embodied carbon as well. As a performance based assessment, the evaluated development shall be awarded based on the sum of carbon emission over the baseline year.

Malaysia and Japan have coordinated in SirimSIRIM-Jetro JETRO project to establish LCA methodology in Malaysia [6]. In 2005, the Japan-Malaysia green partnership programme was commenced in developing life cycle inventory (LCI) as a background data for LCA and eco-labelling type III products. By providing local background data, the time and cost of LCA data collection for LCA implementation can be reduced significantly for industry purposes [14]. This also helps in reducing uncertainty in LCA studies with the provision of local data. Furthermore, this programme was developed in order to attract the small and medium scale enterprises (SMEs) in Malaysia [6]. It includes development of the LCI database for power generation, water supply, oil and gas production and steel production. Within this programme, some LCIA studies were also conducted namely: air conditioner, crude palm oil and pet bottle. The studies examined the main industry players such as FELDA, Golden Hope, MPOB and IOI. In 2017, SIRIM has covered 161 LCI database for various categories, such as electric and electronics, chemicals, construction and agriculture [7]. The other progression is water footprint which derive of life cycle assessment methodologies. There is progress in quantifying within palm oil industry by Malaysia Palm Oil Board (MPOB). SIRIM also actively involved in conducting water footprint studies of specific agricultural produce, industrial product and building services [15].

2.2 Industry Involvement
Internationally, LCA has been accepted a guiding industries to promote sustainable product and service. In early industrial development in Malaysia, the use of LCA application was limited due to absence of required methods. Most of the environmental management systems are focusing on pollution control in order to comply with the strict regulatory requirements by the Environmental Quality Act 1974 [16]. There have been changes in industries’ environmental viewpoint after the
introduction of SIRIM in Environmental Management System (EMS) certification scheme along with ISO 140001 in Malaysia. Instead of a mere compliance requirement, the industry has started adopting environmental guidelines as a tool for sustainable business growth. This is mostly applicable to multinational and export-oriented companies where customer demands towards green product are rising especially from Europe. Striving to remain competitive in the international market, companies started to adopt ISO 14001 standard mainly focused on managing waste produced. Ang et al., 2014[14] have reported that there are few main hindrances in LCA application in Malaysia especially in Small and Medium Enterprises (SMEs) [14]. Since SMEs contribute 36.3% to Malaysia’s GDP across all economics sectors, the issues faced by SMEs in implementing LCA can be a good indicator about industry acceptance on LCA practice (SME, 2015/2016). Ang et al. 2014 [14] reported that the main issues in LCA implementation for SMEs in Malaysia are: 1) less awareness and participation, 2) challenges in data collection, 3) lack of government assistance and directive, 4) short life-span of SMEs and 5) the constraints of Malaysian SMEs [14]. Less awareness and participation in SMEs can be seen from both manufacture/services and consumer perspective. From manufacture perspective, producing green products are dominated by marketing opportunities rather than environmental orientation [17]. Green product mostly has higher price tag as compared with conventional product. Furthermore, with increase of green-washing issue, this has given a bad consumer perception. Another factor that contribute to less participation by SMEs is consumer’s pattern of consumption and behaviour towards green product. A study by Lim et al. [17] 2013 has have found that the consumers in Malaysia have shown low preferences for green products even being labelled environmental- friendly. This is cause by many factors, such as lake of awareness among consumers about the positive impacts of green purchasing. Furthermore, Lim et al. 2013[17] have highlighted a common perception among consumers that individual efforts will not produce significant positive result towards environment and it only affects consumers’ personal well-being. All these reasons have resulted in low demand and perceptions towards green products. In addition, a higher price tag attached to green products decreased customer demands. It changed the focus of manufacturers towards revenue and market competencies [18] to sustain their businesses in the competitive world. In order to increase participation from manufactures and service industries, each member has a role to play. From manufacture perspective, there is a need to balance between the profits and delivering authentic environmental solution to convince consumer that they are contributing to positive impact to the environment [17]. On the other hand, consumers should have better understanding about the negative environmental impacts caused by manufacturing. Furthermore, Ang et al., 2014 noticed the lack of guidance from LCA community that contribute to less SMEs participant [14]. LCA in general is well established and known for environmental management solution. Like other environmental initiatives, implementing LCA concept in organization requires knowledge capacity throughout the organization. Thus, the importance of training within organizations is an essential [19]. The demand of LCA methodology to be used within organizations might contribute to less organization participant in Malaysia [14].

Moreover, lack of data and information to perform LCA are identified as the main obstacle for LCA [20]. In Malaysia, the National LCI spearheaded by SIRIM has covered 161 LCI database [7], but still limited to certain industries. The development of LCI is time consuming [14]. Furthermore, due to lack of expertise, the possibility of mistakes is high, such as failure to impose material balance conditions on inventory data [21]. This has created challenges for LCA implementation in industries in Malaysia. However, progress has been seen since the efforts to develop Malaysia own LCI by SIRIM. Another important concern regarding LCA application in Malaysian Small and Medium Enterprises (SMEs) is lack of government assistance and directive. Hence, there is a need of the government support in two critical areas: financial resource and promotion [14]. A study by Hwang and Tan, 2012 [22] indicated that one of the five obstacles encountered by green building projects is high cost [22]. Thus, financial resource such as tax incentive is important in implementing green initiative. Throughout the years, many incentives have been announced by Malaysia’s government to induce the green initiatives implementations in the country. For instance, companies participating in MyCarbon
Reporting Programme in 2015 and 2016 have been given tax incentive by Malaysia’s Finance Ministry based on three reporting class, namely platinum, gold and silver for consultancy, in-house reporting and third-party verification [23]. In terms of promotion, LCA is not compulsory to implement for organization in Malaysia. However, Carbon Reporting Programme based on LCA framework is mandatory in some countries, such as Australia (The National Greenhouse and Energy Reporting (NGER) Scheme), Canada (Greenhouse Gas Emissions Reporting Program (GHGRP)) and USA (Mandatory Greenhouse Gases Reporting Rules (MRR)). While it is voluntary in Malaysia (MyCarbon), Brazil (Brazil GHG Protocol Program) and Thailand (Thailand Greenhouse Gas Management Organization (TGO). Although, MyCarbon Reporting is a voluntary programme, but it is postulated to be mandatory for company listed under Bursa Saham Malaysia from next year.

2.3 Way forward for the application of LCA in Malaysia

Agricultural sector especially palm oil industry has faced many challenged in terms of deforestation and peatland destruction [24]. Few efforts have been done in terms of replanting and replacing other agricultural crops site instead of opening new area for palm oil plantation. Furthermore, in order to promote sustainable palm oil production, Malaysia has established a roundtable programme about sustainable (RSPO) that includes all stakeholders from palm oil industry. Furthermore, waste from palm oil production such as EFB, fibre and shell have been used as fuel for electricity generation and plant operation [25]. For the purpose of sustainable production, LCA is a crucial factor to evaluate the potential impact from mitigation process. As such, LCA based on climate change impact is a valuable tool to measure the potential greenhouse gases reduction from palm oil production [26]. Moreover, in promoting palm oil to international market, the acceptable environmental tool such as LCA is proven to be beneficial indicator for sustainable palm oil production.

Four areas should be highlighted namely 1) energy, 2) water and waste management, 3) transportation and 4) building [27]. As for energy consumption, Malaysia has highlighted the usage of low carbon fuel energy in National Renewable Energy Policy and Action Plan. This include various tax incentive to stimulate green industry, such as incentive for renewable energy (RE) and energy efficiency (EE), green technology project, services and assets [28]. The utilization of renewable energy such as bioethanol and biodiesel should not be the ultimate solution due to the fact that biofuels have shown poor performance in term of acidification, eutrophication, photochemical oxidation and impacts on agricultural land [29]. In water management, few measures have been taken to protect the water quality through Environmental Quality Act (1974) that includes air, noise and pollution. According to Friedrich et al. (2009), water distribution network itself impact environment due to energy consumption. Furthermore, with the common phenomenon of water shortage in certain places of Malaysia, water recycling is found to be potential alternative [30]. However, this method may not be implemented because of high wastewater strength thus extensive energy and treatment are needed to deliver the water to the customers. In solid waste management, Solid waste treatment such as incinerator is proven to be effective in treating broad range of wastes as well as significant reduce of waste volume and destroying potential harmful substances [31]. However, the acceptance towards this technology in term of solid waste management is very low due to faulty design, improper operation, poor maintenance, high fuel consumption and waste characteristics (high moisture contents) [32]. Beside technical issue, the effectiveness of incineration can be highlighted by implementing LCA in the systems. This is shown by Cherubini et al. (2009) which the incineration with energy recovery and waste minimization to landfill [33].

Construction industries consume considerable energy and materials [34]. Furthermore, Guggemos & Horvath (2005)[35] recorded that construction industries used one sixth of world’s fresh water and one quarter of world’s wood harvest [35]. This however, does not necessarily represent each country resource consumption due to different type of houses in the area. An LCA study by Wen et al. (2015)[36] about construction methods for residential building sectors in Iskandar Malaysia showed the efficiency of industrialized building system (IBS) in energy and global warming control [36]. However, these initiatives ignored other aspects of construction industry, such as drinking water
pollution (40% contributions) and air quality (20% contributions) [37]. Furthermore, Fouche and Crawford, 2017 have highlighted the importance of integrating both environmental and financial elements in building evaluation performance [38]. By providing these elements, the negative impacts can be reduced through mitigation measures in life cycle of building and decision-making process. As for transportation is concerned, to reduce carbon emission, the government has implement the B5 biodiesel scheme (5% biodiesel, 95% fossil diesel) in 2011 with bioethanol blend recommendation in the future [39]. However, despite the government national policy of biofuel since 2005, the Malaysia’s biofuel consumption is still faced with many uncertainties due to various factors [39]. The latest technology of electric vehicles seems to address the issue of carbon emission and fuel cost [40]. This however, needs more electricity production due to high fossil fuel consumption in power generation in Malaysia. Ally and Pryor, 2007) compared three types of fuel for bus (natural gas, diesel and fuel cell power sources) and found that fuel cell is competitive with diesel and natural gas but has higher impacts in term of acidification and photochemical ozone impact [41]. Thus, LCA is relevant with the capability to identify the direct, indirect and supply chain processes that are pertinent across the transportation system [42].

3. Conclusion
Life cycle assessmentLCA has been a valuable tool to evaluate the potential environmental impacts from product or service activities. In term of LCA progress, the concept of LCA is being gradually accepted in developing countries from government action plan in moving towards sustainability. In Malaysia, the government have applied life cycle principle in managing product and service towards sustainable development and can be seen in one of six strategic thrust in pursuing green growth for sustainability and resilience. These initiatives were based on life cycle principle are carbon reduction initiative and national database development. An example of carbon reduction initiative are national voluntary carbon reporting programme, policies and regulation, tax incentive, green labelling and certification and carbon indicator. In adopting life cycle approach in Malaysia’s industries, few issues raised which hindered the LCA application. With motivation from Malaysia’s government initiatives as well as international market pressure these challenged can be reduced.

As for LCA priorities in Malaysia, it can be seen from economic wise as well as environmental issue faced in Malaysia. In agriculture sector, LCA can help as a tool in commodity sector especially palm oil industry towards sustainable production. Furthermore, aligned with green economic development, four priority areas for low carbon growth namely 1) energy 2) water and waste management 3) transportation and 4) building should be the other priorities for LCA application. As such in energy sector, Malaysia’s strategies in reducing the fossil fuel utilization and using biofuel as alternative should be comprehensively support with LCA study as biofuel such as biodiesel is proven beneficial in term of climate change impact but has shown disadvantageous in others impact especially related with agriculture activity. LCA is also important in emphasizing the benefit of technologies such as in case of incineration in solid waste management. Thus, LCA is relevant with the capability to identify the direct, indirect and supply chain processes that are pertinent across the system.

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