

# Development of National LCA Database Roadmaps, including further Development of the Technical Helpdesk for National LCA Databases

Deliverable D 4.4: final roadmap report for Sri Lanka

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## Executive Summary

Life cycle assessment (LCA) provides a standardized evaluation methodology for effective decision making with a holistic environmental perspective. For conducting LCA studies, life cycle inventory (LCI) data on resource requirements and environmental interventions are the key inputs. Useful and meaningful LCA results can be obtained when high-quality data appropriate to the locational scenarios and conditions of the study, reflecting the local situation in terms of raw materials, utilities, technology levels, waste management practices, etc. This creates the requirement of a national LCA database for a country that could provide country-specific data in a more robust, consistent, and compatible manner for standard LCA practice. In Sri Lanka, the standard LCA practice is not wide-spread but there is a quite significant improvement in the field of sustainability initiatives and related data collection. The National Cleaner Production Center, Sri Lanka in (NCPC-SL) is the pioneering institute in the country that takes immense efforts to establish LCA expertise and related activities in Sri Lanka. NCPC-SL has led many LCA related projects and initiatives in the country in the past. The current project titled “*Development of National LCA Database Roadmaps, including further development of the Technical Helpdesk for National LCA Databases*” running from October 2018 until July 2019, commissioned by UN environment and the Life Cycle Initiative and funded by the European Commission, is coordinated by theecoinvent Association in Switzerland, and includes project partners from Sri Lanka, Brazil, Ecuador, India, South Africa, and Uganda. NCPC Sri Lanka acts as the national project partner in this initiative with an ultimate objective of developing a national LCA database for the country.

To meet the objectives of this project, a National Database Working Group (NDWG) was formed by NCPC-SL to prepare the roadmap for a national database development. Meetings for stakeholder consultations were called for an increased effort to prepare the roadmap for the database. Participants of these meetings stressed the importance of LCA practices in Sri Lanka and the value of using LCA for country's policy decisions, products/services development, and environmental regulating practices. The meetings steered in search of possible actions to promote LCA practices through a national LCA database. This roadmap report contains the final outcomes and concrete next steps for implementation of the national LCI database, based on the ideas, viewpoints, and genuine concepts from the LCA stakeholder community of the country.

The outcomes of the NDWG meetings first formed a draft roadmap report that was further reviewed and discussed among the members in NDWG and members in the International Working Group (IWG) of the roadmap project. Physical meetings as well as online communications through skype and emails took place to improve the roadmap report up to a standard level addressing the required deliverables of a national LCI database development. Primary goal of the national LCA database development for Sri Lanka was outlined as to provide country-specific, quality LCA data with a proper availability after a critical review for supporting LCA activities in the country. The vision of the LCI database roadmap for Sri Lanka is to create an authoritative, transparent, consistent, and reliable platform that provides easily accessible, up-to-date, quality LCA data on the country's major products, services, and sectors (e.g. transportation, utilities, etc.) and promote the practice of life cycle assessment for their environmental analysis and decision-making. The constructive outcomes from NDWG discussions mapped a suitable layout of the governance structure for LCI database development in Sri Lanka. This governance structure contains a lead organization as the database management body and the database hosting agent. The roadmap project partner, NCPC-SL was attributed to the database management as the lead organization for the overall coordination responsible for the database creation, content, maintenance, and updating with the help of working committees, such as a steering committee, advisory board, and other supportive working groups for different tasks of database development (i.e. IT, Review, Data collection, Fund raising, etc.)

The discussions further outlined possible funding sources, human resources requirements, and steps to follow in data handling for different activities in the roadmap implementation. The data needs and key data sectors were identified which led for the guidelines to follow on standard data quality requirements for the database. The final recommendations through this roadmap development formed a five-years comprehensive roadmap implementation plan, including concrete next steps to implement for national LCI database development in Sri Lanka.

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# 1 Introduction

The strategic plans for sustainable development of a country are focused on new/modified products, processes, and services in terms of improved energy efficiencies with reduced environmental impacts. Effective decision-making for more sustainable products/services requires an extensive range of reliable and updated data about their environmental consequences. Life cycle assessment (LCA) is a holistic and systematic evaluation technique of environmental impacts of a product or service as well as of organizations or consumption patterns that supports decision making in all sectors of a country on policy planning/implementation, product design or purchasing decisions, process operation, and research/development.

LCA analyzes the environmental impacts associated with a product or service throughout their life cycle or value chain from raw material extraction to the final disposal. When there is no prompt availability of high-quality life cycle inventory (LCI) data related to each product stage, LCA practitioners would have to collect raw data through data survey methods or adopt foreign data and adjust them for country-specific conditions. This way of LCI data collection could undergo many variations/biases due to the individual considerations by different LCA practitioners. Thus, development of a national LCI database is essential for consistent applications of the LCA approach for country-specific products and services.

The LCA approach is new to Sri Lanka but there is a steady progress with some single impact category LCA studies, few full product LCAs, and background data collections. There is a wide availability of data related to the major products and services in the country. These available data are in different formats and used for different objectives rather than LCA. The government and other related statutory bodies have acknowledged the importance of the LCA approach to achieve sustainable development goals for the country. However, a strong governmental policy has not yet been established to mainstream the LCA data at national level. Accumulation of the available data in a usable form in a national database would be very helpful for promoting LCA studies in Sri Lanka as well as for the decision-making process in implementing sustainable development practices. This report discusses the progress of the LCA initiatives in Sri Lanka for the preparation of a roadmap to develop a national LCI database and its implementation.

## 1.1 Status of LCA in Sri Lanka

In Sri Lanka, several important steps have already been undertaken to promote life cycle thinking and LCA approach among the public organizations and private sector enterprises in order to transform them from merely complying with environmental regulations to proactive environmentally responsible decision-making. The National Cleaner Production

Centre, Sri Lanka (NCPC-SL) has been the pioneering contributor for knowledge expansion and facilitator to promote the LCA approach in Sri Lanka. From the past years (2005-2018), NCPC-SL has organized several trainings and other capacity building programs with an objective of creating a launch pad to mainstream the LCA approach in Sri Lanka. Table A1 in the Appendix lists the organized LCA related training programs. Formal education on concepts and techniques for LCA approach is also vital in addition to the specified training programs for LCA practitioners. Majority of the universities in Sri Lanka offer environmental sustainability related courses and topics related to the LCA approach as a part of the courses in their undergraduate/postgraduate degree programs (Table A2 in the Appendix).

National level academic/industrial research on LCA related topics is another crucial capacity building aspect in order to generate country-specific background LCI data. Even though application of the LCA approach in national policy makings is at a low level, several research groups in Sri Lanka engage in continuous LCA-related research. The main emphasis of the research carried out by these groups are on the life cycle environmental impact assessments of selected products. The impact categories covered under these studies vary from a single category, such as climate change to multiple impact categories.

Moreover, there have been several research conferences/symposiums held in Sri Lanka where LCA-related research findings by the local researchers and industries were presented (Table A3 in the Appendix). Sri Lanka has also been able to receive international assistance through different projects to implement LCA related activities. More details of national projects conducted on LCA development in Sri Lanka have been summarized in the Appendix.

## **1.2 Availability of national LCA data**

With the help of many capacity building programs and LCA development projects, there is a considerable increase in the usage of LCA-related tools in Sri Lankan industries for evaluating environmental performance of their products (i.e., product LCAs). Few full scale LCA studies on products, such as tea, rice, and dairy have been carried out in Sri Lanka. In addition, some more studies have been carried out on single impact category evaluation, i.e., carbon footprint, water footprint, etc. (Table A4 in the Appendix). These assessments have been either conducted by private sector service providing organizations or academics/researchers. National LCI data of some products and the services in Sri Lanka are already available from these studies.

In addition to the available studies, it is obvious that Sri Lanka needs comprehensive LCAs (including impact characterization, sensitivity/uncertainty analyzes) on many of the country-specific products and services. At present, the capability of conducting LCA studies

in Sri Lanka are limited due to the lack of LCI data availability in the national scale, and foreign background databases available in the LCA software do not include specific data for the Sri Lankan context. The accuracy of the conclusions made by the LCA depends on the relevance and lower uncertainty of data used in the analysis. Therefore, implementation of LCA approach in the country would be infeasible without a national life cycle inventory (LCI) database at least for the most economically important products and services, such as electricity generation, transportation, agriculture, and common utilities like water and fuel. The advantages of a national LCI database could be listed as follows.

- Providing key information for policy and decision makers to perform comparisons among possible options regarding environmental decisions.
- Enabling proper evaluation of alternative product systems for environmental opportunities, trade-offs, and monetize environmental externalities. e.g. carbon trading, energy credits, etc.
- Identification of environmental hotspots of products/processes and modification of key environmental hotspots for environmentally benign performance.
- Comprehensive LCAs of products and services based on quality LCI data would provide facilities to expand the export markets.

### 1.3 Brief summary of present roadmap project

National Cleaner Production Centre, Sri Lanka recognized the growing demand for LCA and the need to develop a national LCI database in order to establish a source of high-quality transparent data of Sri Lankan products/services that are compatible with the international standards. With this objective, NCPC-SL joined hands as the national project partner for Sri Lanka with the project “*Resource Efficiency through Application of Life cycle thinking (REAL)*” which is a part of the UN Environment hosted Life Cycle Initiative and funded by the European Commission. The overall goal of the REAL project is to integrate resource efficiency in global value chains by using life cycle data on environmental impacts. One of the components of the project is aimed at supporting the development of life cycle databases, enhancing access to databases as well as furthering their interoperability. The present LCI database roadmap development project addresses this component of the REAL project.

Running from October 2018 until July 2019, the project is led by theecoinvent Association in Switzerland, and includes project partners from Sri Lanka, Brazil, Ecuador, India, South Africa, and Uganda. Overarching project activities are coordinated and carried out by an **International Working Group (IWG)**, comprised of representatives from each

participating country, the European Commission, and UN Environment. The consortium of national project partners in the IWG are as follows.

- **Project lead:** ecoinvent Association, Switzerland (Dr. Carl Vadenbo)
- **Sri Lanka:** National Cleaner Production Centre, Sri Lanka (Mr. Samantha Kumarasena, Ms. Upendra Arjeeewani Weerathunga)
- **Brazil:** Universidade Tecnológica Federal do Paraná (Prof. Cássia Ugaya)
- **Ecuador:** Escuela Superior Politécnica del Litoral (Prof. Ángel Ramírez); Escuela Politécnica Nacional; Ministry of Environment; Conservación Internacional Ecuador
- **India:** National Environmental Engineering Research Institute (Dr. Rajesh Biniwale); Confederation of Indian Industry (Ms. Nisha Jayaram); Dr. Sanjeevan Bajaj, independent consultant
- **South Africa:** University of Cape Town (Prof. Pippa Notten, Prof. Harro von Blottnitz)
- **Uganda:** Uganda LCA Network (Mr. Paul Walakira, Mr. Dean Tashobya)

The objective of this project is to develop national LCA database roadmaps in different countries as well as to advance on the availability of actual databases in those countries that already have a sufficient level of maturity. In addition, the objective is to further contribute to the development of the Technical Helpdesk for National LCA Databases to support database development, globally. Figure 1.1 illustrates the key project activities with respect to the project timeline.

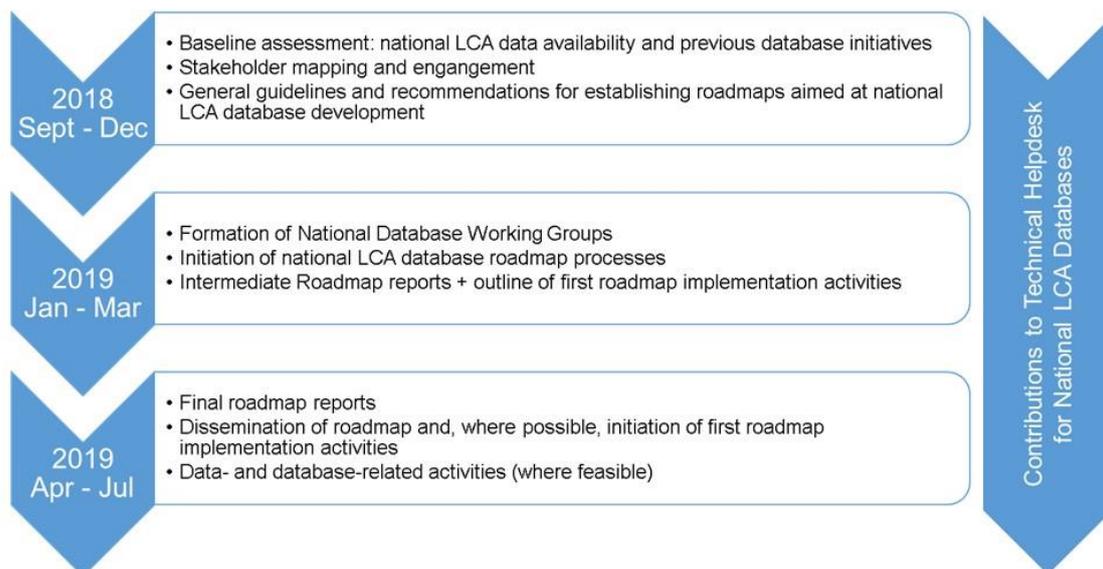


Figure 1.1: Key project activities with respect to the project timeline

As the national project partner for Sri Lanka, NCPC-SL carried out baseline assessments of the current state of national LCA data availability and any previous LCA database initiatives as well as stakeholder mapping and engagement in Sri Lanka. This served as the basis for the formation of a National Database Working Group (NDWG).

This final roadmap report describes the inputs obtained from the NDWG meetings and communication with other stakeholders. The target audience of this roadmap report is the LCA stakeholders in Sri Lanka, representing ministries, government institutes, universities, LCA practitioners, companies in eco-business, and related industries. This report is intended to be used as a guide to plan and initiate first roadmap implementation activities and further develop the plans and activities towards a successful implementation of a national LCI database for Sri Lanka.

## 2 Roadmap establishment process

### 2.1 Baseline assessment and stakeholder mapping

There would be no LCA practices in a country without stakeholders. The stakeholders should represent all the interested parties in the project, the people who can provide significant influence on the project, as well as those who will be affected by implementation of the project. Focusing on roadmap development for the national LCA database, it is critical to perform a proper stakeholder analysis and mapping. This will help to identify and sort out the key stakeholders in the field of LCA as well as the types of input they require, kinds of communication they might need, and many more. The stakeholder mapping was performed to identify and classify the stakeholders and their levels of influence/contribution for the national LCI database development. According to this selection criteria/method, three types of stakeholders were sorted out as follows.

- Key stakeholders: those with significant influence/contribution/benefits on the national LCI database (roadmap) development; can also belong to the other groups.
- Secondary stakeholders: the "intermediaries," those who have indirect contributions/influences/benefits on the national LCI database (roadmap) development.
- Tertiary stakeholders: those who will influence/contribute the least on national LCI database (roadmap) development.

In the stakeholder mapping process, the major public/government, industries/private sector, academics/researchers and other influencing parties on database development were selected. Table 2.1 lists the identified stakeholder groups through mapping.

Thereafter, the selected stakeholders were contacted and consulted via different ways of communication (i.e., e-mails, official letters by post, telephone conversations, on-line/physical meetings, etc.). Some of the stakeholders, such as ministries, state institutes, universities, and members of Life Cycle Assessment for Design Sustainability Network (LCADeSNet) already had continuous and close consultations with the project partner (NCPC-SL) even before this roadmap project.

Table 2.1: Identified stakeholder groups through mapping

Stakeholder Type	Stakeholder group			
	Public sector	Industry and the private sector	Academia and research	Civil society and others
Key stakeholders	National Cleaner Production Centre, Sri Lanka	MAS Holdings	University of Moratuwa	LCADeSNet Sri Lanka
	Ministry of Mahaweli Development and Environment (MoMDE)	INSEE/Siam City Cement	University of Peradeniya	Biodiversity, Sri Lanka
	Central Environmental Authority (CEA)	Carbon Consultancy Company	University of Colombo	Institute of Environmental Professionals, Sri Lanka
	Sri Lanka Sustainable Energy Authority (SLSEA)	The Sustainable Future Group (Pvt) Ltd	Sabaragamuwa University of Sri Lanka	
	Sri Lanka Standard Institution (SLSI)	Dynawash (Pvt) Ltd	University of Sri Jayewardenepura	
	Department of Census and statistics	Control Union Inspections (Pvt) Ltd	University of Ruhuna	
	Ministry of Industry and Commerce	Wijaya Newspapers (Pvt) Ltd	University of Kelaniya	
	Industrial Development Board	Ceylon Chamber of Commerce	Sri Lanka Institute of Information Technology	
	Coordinating Secretariat for Science, Technology, and Innovation (COSTI)		Research Institutes (Tea, Rubber, Coconut)	
	Department of Agriculture			
Export Development Board				
Secondary stakeholders	Consumer Affairs Authority	Unilever Sri Lanka Limited	National Engineering Research and Development Centre (NERD)	Sri Lanka Dairy Association
	Ministry of Power, Energy, and Business Development	CIC Holdings PLC		Planters Association, Sri Lanka
	Ministry of Agriculture and rural economic affairs	Hayleys PLC	Department of Meteorology	
	Ministry of Primary Industries and Social Empowerment	Halcyon (Pvt) Ltd		

## **2.2 National Database Working Group (NDWG)**

The selected stakeholder organizations in Table 2.1 were sorted based on the stakeholder mapping method. According to the results of the stakeholder mapping, the key stakeholders with active support and background of past LCI data related experiences were invited to take part in a National Database Working Group (NDWG) in order to develop the LCA database roadmap. Table 2.2 indicates the composition of the NDWG. The group size of the NDWG was around 10-15 stakeholders from different organizations covering-up representations from important key sectors/stakeholders in the stakeholder mapping. The task of the NDWG was to work on the national database development process and consult the wide number of other stakeholders in order to obtain their active contribution for the roadmap development process. The comments/feedback from a wider stakeholder audience on the roadmap development were presented in the NDWG meetings. Following the outputs on the next steps/implementation activities, the final version of the roadmap and execution plan was prepared.

## **2.3 Roadmap report writing process and dissemination activities**

The lead authorship for the roadmap report writing process is held by the project partner NCPC Sri Lanka. Compilation and writing of the NDWG meeting outputs into a draft roadmap report was carried out by a NDWG member, Dr. Mahinsasa Rathnayake (Lecturer, University of Moratuwa, Sri Lanka) and the compiled draft roadmap reports were further reviewed by NCPC-SL, other NDWG members, and IWG members leading to the final versions of intermediate and final roadmap reports for Sri Lanka prior to the dissemination of the final roadmap report.

Table 2.2: Composition of national database working group (NDWG)

<b>No.</b>	<b>Stakeholder organization</b>	<b>Representing individuals</b>	<b>Position In the organization</b>
01	National Cleaner Production Centre, Sri Lanka (Chair)	Eng. Samantha Kumarasena Mrs. Upendra Arjeewani	Chief Executive Officer RECP Expert
02	Ministry of Industry and Commerce	Mr. N.G. Panditharathne	Additional Secretary
03	Ministry of Mahaweli Development and Environment	Mrs. Kema KasthuriArachchi Ms. Chandima Mohottige Mr. Jagathdeva Vidanagama	Environment Management Officer Technical Coordinator -TNC
04	Life Cycle Analysis and Design for sustainability Network (LCADeSNet-SL)	Prof. Parakrama Karunaratne	President
05	Central Environmental Authority (CEA)	Mrs. Sukitha Ranasinghe	Assistant Director
06	University of Peradeniya	Dr. Asela Kulathunga	Senior Lecturer
07	Sabaragamuwa University of Sri Lanka	Dr. Sampath Wahala	Senior Lecturer
08	University of Moratuwa	Dr. Mahinsasa Rathnayake	Senior Lecturer
09	University of Kelaniya	Dr. Priyantha Epa	Senior Lecturer
10	Sri Lanka Standards Institution	Ms. Samanthi Narangoda	Director (Systems Certification)
11	Colombo Commercial Fertilizers Ltd	Dr. Jayantha Weeraratne	General Manager
12	MAS Holdings	Mr. Eranga Dilhan	General Manager (Sustainability)
13	INSEE-Siam City Cement	Mrs. Arosha Hemali	Business Development Manager
14	Carbon Consultancy Company	Mr. Sanith Wijyaratne	Chief Executive Officer

## 3 Roadmap for developing a national LCA database

### 3.1 Vision and goals

An effective roadmap for the national LCA database development must address the related context, the motivation for having the database, and the needs of its potential users. The conceptualization of vision and strategies for the national LCA database development for Sri Lanka was discussed in NDWG meetings, based on the provided guideline by considering key aspects, such as why a national LCA database exists, for whom, and how it will help them.

It was identified that the primary goal of the national LCA database development for Sri Lanka is to provide country-specific, quality LCA data with a proper availability after a critical review for supporting LCA activities in the country. For clear understanding of service levels, the required factors/features were considered to formulate a vision statement and goals of the national LCA database development suitable for Sri Lanka. The required factors/features were listed as follows.

- **Accessibility/compatibility**

- Whether the data in the database are publicly available free of charge. If so, it can affect the viability of the database due to lack of finance.
- The database should be available for non-commercial purposes (professional researchers, research students, etc.) with free of charge and a reasonable fee should be included for commercial purposes.
- For commercial purposes, charging an annual license fee (membership fee) and then free of charge access to database could also be possible.
- For the privacy requirements, every user should register providing their personal details before accessing the database. The purpose of using the database (commercial or non-commercial purpose) can be identified by the user registration.
- Global accessibility/compatibility: The data in the database should be compatible and connected with Global LCA Data Access (GLAD) for standard LCA practice and software tools where a user can access the database anywhere in the world. There must be a fee, charged for the user from other countries.

- **Industry participation and support in use**

- Form an LCA practitioners' network in order to provide technical guidance to users for handling the database because most of the users (specially the industries) do not have

sufficient expertise to handle it. Then for that purpose, a consultant fee can be charged by the database hosting agent.

- **National policy use and compatibility**

- Need of an LCA database as a fundamental tool for promoting LCA in the country through green public procurement policies, such as eco-design, eco-labelling, product carbon footprint, etc.
- Data feed from the already collected data, such as the national greenhouse gas inventory database, developed by the ministry of environment in Sri Lanka.

- **Transparency and quality**

- A proper review process on the LCA data quality before they are included in the database. In addition, the users should clearly perceive the reliability and representativeness, up-to-date data versions, and the transparency of the data.
- The frequency of data update in the national LCI database was proposed as 5 years, subjected to the assessment of existing and new data in every 3 years.

- **Comprehensive coverage of data**

- Commonly used products/services in the country should be included by considering the common life cycle phases: Raw Material Extraction, Agriculture/Fisheries/Forestry, Manufacturing/Service, Energy Systems, Transportation, Waste and Secondary Resource Management.

A vision statement for the national LCA database development was prepared, based on the above major factors, as follows.

### **Vision Statement**

*“The Sri Lankan LCI database will be the authoritative, transparent, consistent, and reliable platform that provides easily accessible, up-to-date, quality LCA data on the country’s major products, services, and sectors that promote the practice of life cycle assessment in Sri Lanka for their full scale environmental impact analysis and decision-making.”*

The following goals were outlined for the national LCA database roadmap development.

- Easy accessibility for national LCI data promoting LCA practices for environmental decision-making in the national scale.
- Provide authentic LCI data with standard quality, transparency, and reliability.
- Up-to-date and properly reviewed LCI data covering commonly used materials, products, and processes in Sri Lanka.
- Support LCA practitioners, industries, and researchers in the related fields providing data compatible with international LCA databases/tools.

The next steps related to the vision and goals of this roadmap development in the first implementation activities would be mapping the developed goals with the public policies in Sri Lanka and other uses that the national LCI database should support.

### **3.2 Governance and management**

The national database development requires a structured management team with a key steering committee, advisory board, and database management with working groups for its successful implementation. The LCA data may need maintenance and updating works over time due to changes in the materials, technologies, and processes. Therefore, a comprehensive governance structure with continuous operation on the database is very important for the database viability. In addition, there are many tasks and responsibilities to collect required up-to-date data, maintain the consistency among datasets, adherence to quality requirements and rules, technical support activities in Information Technology (IT) related software development platforms, and financing for the database development and maintenance. To address these task requirements, the composition of the database governance structure was discussed referring to the roadmap development guidelines.

Figure 3.1 shows the proposed layout of the governance structure for LCI database development in Sri Lanka. Through the discussions had in the NDWG meetings, NCPC-SL (the roadmap project partner) was attributed as the lead database management organization for the overall coordination and the database hosting. This decision was further approved by the stakeholders participated to the national LCA conference held on 30<sup>th</sup> May 2019, where this final roadmap report was disseminated among a wide stakeholder audience.

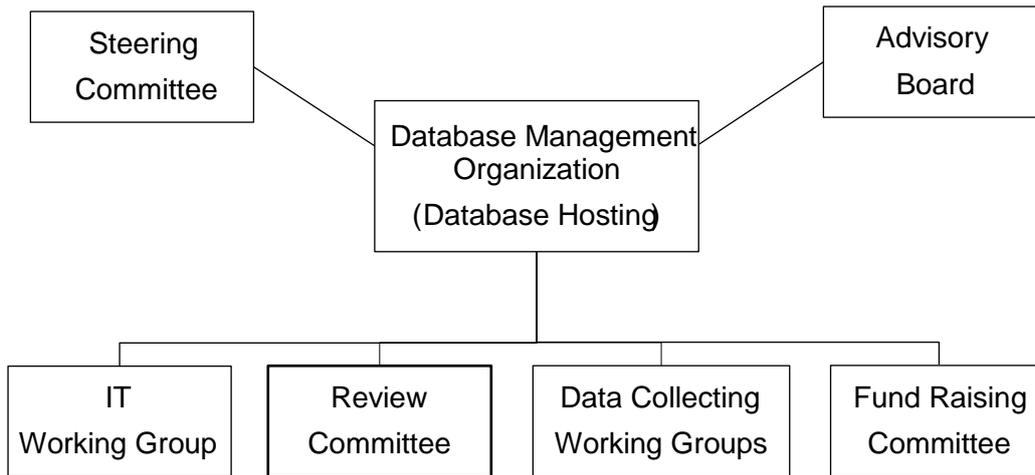


Figure 3.1: Layout of governance structure

A steering committee and an advisory board will be nominated by NCPC-SL as separate entities for supporting the database governance. The steering committee and advisory board would consist of members from the lead organization, consultants representing the NDWG, and representatives from primary stakeholders as well as from financing agents/organizations. Appointment of the individuals to the steering committee and advisory board (size of 5-10 individuals in each) is a task of the lead organization (NCPC-SL), based on their expertise and the level of contribution that they provided for the roadmap development process. All these individuals are voluntary positions, but appropriate consultation fees would be paid as an honorarium for their contribution of work. All the appointments to the steering committee and advisory board will follow signing an agreement (formal appointments of individuals in all committees and working groups followed by mutual agreements) between the NCPC-SL and the appointed consultant in individual basis. This strategy can secure the commitments of the roles in the governance structure outside NCPC-SL, and the risk of unattended responsibilities by participating/supporting organizations and individuals beyond the direct control of the lead organization (NCPC-SL) could be overcome.

The responsibilities of the advisory board would be advising and assisting the database development tasks of each working group (i.e. committees for IT, review, financing, data collection) as well as the lead organization (NCPC-SL) and the steering committee. The steering committee would overlook and support for the important decision making of the database roadmap implementation process, etc. The composition of the steering committee and advisory council are as follows.

### **Steering committee**

- Ministry of Mahaweli Development and Environment
- Ministry of Industry and Commerce
- Ministry of Power, Energy, and Business Development
- National Cleaner Production Centre (NCPC-SL)
- Central Environment Authority
- Sri Lanka Sustainable Energy Authority
- Department of Census and Statistics
- Department of Agriculture
- Ceylon Chamber of Commerce for industry collaboration
- Life Cycle Assessment for Design Sustainability Network (LCADeSNet-SL)

### **Advisory board**

- University academics
- Researchers from research institutes
- Sri Lanka Standards Institute
- Industry-oriented LCA practitioners, LCA-related consultancy providers
- International experts in LCA data-related activities

According to the stakeholder consultations, it was agreed to have four main working groups, such as IT, review, fund raising, and data collection committees to carry out the LCA database development, implementation, and maintenance works within the database management. The IT working group gets the responsibility of developing the database software platforms to store datasets and updating data formats in the database, and providing the technical support to maintain an up-to-date LCI database. The IT working group will be formed based on the following considerations.

- An IT working group will be formed consists of staff members (paid positions) of the database hosting agency (NCPC-SL). Through a legal agreement, the outsourced expert will be given the responsibility of training the internal IT working group.
- The IT working group will be trained for the database-related software activities (i.e. data storing, inserting, updating, etc.) in the implementation and maintenance phases of the LCI database.

The IT working group should have a close relationship with the review working group who are responsible on deciding the quality of datasets in the database. A high-quality review process is required to approve the available and generated data before inserting into the database. Thus, the LCI data review committee (voluntary positions) must include academics,

senior researchers, and individuals who have satisfactory experiences with data quality assessment and handling LCI data.

A genuine coordination between IT and review working groups can avoid inserting low quality data into the database and the risk of any counterfeit data. In addition, the review committee has to initiate/coordinate data collection efforts of the data collecting working groups in different sectors, establish data quality requirements, submission and review procedures, ensure database functionality, perform analyses of data in the database, and ensure interoperability with other data sources.

Working groups should be formed to conduct data surveys on existing product/service processes, LCA related laboratory experiments, pilot plant operations different data sectors to generate feed data into the national LCI database. The database management organization can coordinate and support data collection efforts as research projects at university level, special projects in the industries, etc. Thus, multiple data collection working groups can be formed based on the data requirements and they will play a key activity for the implementation and maintenance of the national LCI database because the available LCI data at present are limited and there are requirements of new data collections in many of the major data sectors in Sri Lanka.

The other most important working group is the fund-raising committee. The composition of this group can include representatives from government/ministries, national policy makers, funding bodies and stakeholders in business planning field. The main roles and responsibilities of this group are identification of the financial requirements of the database development/maintenance, assisting the database management organization to develop the business plan/financing budget, communication for obtaining required funds from the funding agents, and documentation activities for the database development and implementation.

Table 3.1 summarizes the specific roles, responsibilities, and possible organizations/individuals in the entities of the governance structure. For the next steps, appointment of these separate entities in the governance structure is one of the key activities in the first roadmap implementation activities. If prioritized, the steering committee and the advisory board must be first formed. Then, initial actions, such as decision making of financial budget/business plan and formation of other working groups could be carried out. The first action through other working groups is data collection.

Table 3.1: Roles, responsibilities, and composition of governance structure

Steering Committee	Advisory Board	Database Management Organization (NCPC-SL)			
		IT Working Group	Data Collection Committee	Review Committee	Fund Raising Committee
Overlooking and supporting for the annual operating plan, business plan, and budget for database development, implementation, and maintenance.	Advising/assisting the database development tasks of each working group (i.e. committees for IT, review, financing, data collection) as well as the database management organization (NCPC-SL) and steering committee.	Outsourced: Developing the database software platforms to store datasets. Group in host agency: Feeding converting data to match with the database. Updating data formats and protocols in the database.	Collection of LCA data for the sectors identified in the roadmap implementation plan and obtaining review and approval of the collected data from the review committee. Conducting background LCA studies for data collection.	Defining a data quality regulation/measurement scheme (data protocol). Determining and revising required data formats and data protocols for the database entries.	Developing the business plan/financing budget for database development and maintenance. Communication for obtaining funds and required documentation work.
<u>Possible member organizations</u> Ministry of Mahaweli Development and Environment, NCPC-SL, Central Environment Authority, Sri Lanka Sustainable Energy Authority, etc.	<u>Possible member organizations</u> University academics, Researchers from research institutes, Sri Lanka Standards Institute, Industries oriented LCA practitioners.	<u>Possible member organizations</u> Outsourced: University of Moratuwa, University of Colombo, Sri Lanka Institute of Information Technology, Private companies in software development. Group: NCPC-SL Staff	<u>Possible member organizations</u> University academics, Researchers from research institutes, LCA practitioners, LCA related consulting companies, etc.	<u>Possible member organizations</u> Sri Lanka Standards Institution (SLSI), Central Environmental Authority (CEA), academics and researchers from universities/research institutes, LCADeSNet-SL.	<u>Possible member organizations</u> Central Government, Ministry of Mahaweli Development and Environment, Department of Census and Statistics, International funding agents, NGOs.

### 3.3 Funds and Financing

Obtaining necessary funds and financing is a crucial step for the LCA roadmap implementation and maintenance of the database after implementation. A strategic business plan is required initially and there should be an annual update to this business plan to support the database management to plan human resources involvement and required budgets. This business plan may include the revisions of the vision statement, goals of the database project, and the formation and operation of the governance structure. The suggested duration of the business plan for the national LCI database development is five years. This initial database development period (five years) should be managed with a well-planned budget along with the business plan. Thus, funding requirements and funding sources must be clearly identified for the database development activities. The major funding requirements could be classified as the funds for the database start-up process, including the appointment of the governance structure, funding for new data generation with metadata descriptors, capacity building, connection of data with GLAD, and database maintenance.

The possible organizations and funding sources that could contribute for funding and financing of the LCA database development/maintenance activities were identified and classified as follows.

#### 1. Possible funding sources for database development activities (initial phase):

Local funding sources: Central Government, Ministry of Mahaweli Development and Environment, Department of Census and Statistics, Industries promoting sustainable practices, etc.

International funding sources: International grants for promoting LCA, United Nations Environment Program (UNEP), United Nations Industrial Development Organization (UNIDO), The Life Cycle Initiative, the European Commission (EU), international NGOs, donor agencies, etc. The donor agencies could be provided a temporary position in the advisory board to overlook how their funding would be utilized for the database development activities.

#### 2. Possible funding sources for database maintenance after implementation:

Central Government, Ministry of Mahaweli Development and Environment, Self-funding from data sales, license fees payable by industrial/commercial LCA practitioners, trade associations for developing/maintaining datasets on their products/services, etc.

The funds from the central government can be obtained by presenting a special project proposal for the annual government budget. In addition, the funds from Ministries can be taken from ongoing projects (as Co-financing). Furthermore, it was suggested in the NDWG

meetings to incorporate implementation of the LCA activities and national LCA database development into the action plan of the ministry of Mahaweli development and Environment in order to obtain direct access funds. Donor agencies, such as NGOs, trade associations, industrial collaborations, etc. can also provide a fair amount of funding in the roadmap implementation process.

In the next steps for roadmap implementation activities are writing proposals to obtain central government budget allocations as well as funding from international projects by foreign development agencies and international NGOs. In these activities, a fair amount of documentation tasks would be available to secure the obtained funds. These activities should be carefully attended and fulfilled by the fund-raising committee.

The possible funding sources for different database activities have been summarized in Figure 4.1 under the section 4. Roadmap implementation plan.

### **3.4 Human Resources**

When implementing the roadmap for a national LCA database, local experts can be hired for technical aspects, such as software platform development for the database hosting and generating/reviewing datasets for inclusion in the database. Setting up the data standards and quality requirements and procedural guidelines could be conducted by the experts in the field of data review in Sri Lankan universities and research institutes. In addition, the amount of people involved to provide data for the LCA database depends on the goals and the intended scope of the database. For example, exchanging data in the database by harmonizing into a data format (i.e. ILCD, ecoSpold2, etc.) requires the support of international experts from the Joint Research Centre (JRC) of the European commission, theecoinvent Association, the Life Cycle Initiative, United Nations Environment Program (UNEP), etc.

Data from a national LCA database can be used for several purposes: development of public policies, consumer information, LCA studies in research/industry improvement, etc. In LCA practitioners' perspectives, LCA studies require various data for several types of processes (energy, transportation, material, agriculture, infrastructure, etc.). Therefore, research teams from different areas and backgrounds are required to be assigned for data collection and inventory generation. In addition, a common requirements of data attributes should be maintained for the consistency of data. In this manner, many trainings and capacity building activities are required for human resources development in database roadmap implementation activities, e.g., training of IT operations in database development/maintenance activities for IT working group of the national LCI database.

For Sri Lanka, some capacity building programs were organized by NCPC-SL. Hence, capable human resources are already available in the country and some more additional trainings in specific areas would prepare them as the staff for the database roadmap implementation work. For example, data collection working groups attached to universities, research institutes, etc. for new LCI data collection to feed the national database must be provided a training and guideline regarding the service levels, data quality requirements/required metadata descriptors, etc. As next steps, the expenditures for these capacity building programs must be included in the business plan and budget proposals of the roadmap implementation, accordingly.

## **3.5 Data and database**

### **3.5.1 Database hosting**

As described in the section 3.2 on the database governance and management, NCPC-SL was identified as the hosting agency for the national LCA database in Sri Lanka.

There are responsibilities and infrastructure requirements when hosting a database. The system must be secured from malicious acts and at the same time easy to use and available for users. Hence, the database hosting was suggested to implement in order to ensure proper function and coordination among technical support requirements for the database in the following manner.

- NCPC-SL was suggested as the database process hosting agency with the overall responsibility.
- The advisory board to supervise the data handling, Review Committee to review and check the quality of LCI data, and IT working group to feed the relevant data and convert the data in required formats for interoperability/compatibility.

The major service levels of the national LCI database development in Sri Lanka, such as easy accessibility, data quality assurance, promoting national LCA practices, etc. should be addressed through the database hosting. NDWG meetings suggested that for the accessibility of LCA practitioners and promoting LCA in the country, datasets in the national LCI database will be made available to obtain through a website with user management. A database user must enter and submit all credentials with a request for the required dataset. Then, the database hosting agency has the right to issue the requested data as a standalone unit process or a set of datasets linked to each other through 'functional' product systems. The standard policy of data issuance was confirmed as follows.

- Free of charge data issuance upon request: For universities, students, research institutes, government institutes funding the database implementation.
- A fee for dataset or complete license to access LCI database: For industries, local LCA practitioners using the datasets for commercial purposes, and foreign practitioners/organizations.

### 3.5.2 Data needs and availability

As identified in the baseline assessment, there are already available datasets developed by different institutes in Sri Lanka, including NCPC-SL, the ministry of Mahaweli development and environment, central environmental authority, etc. However, most of these datasets have not been reviewed for the data quality and validity, nor for data compatibility with international LCI data standards. Thus, the available data will be reviewed, updated, and augmented/harmonized as necessary.

A structured data management plan will be prepared by NCPC-SL with the help of the advisory board and database review committee to convert available data according to comprehensive and consistent database formats that follow International Organization for Standardization (ISO) requirements. The compatibility of the data format with international LCA tools, levels of data quality, and data validation procedures will be defined and implemented in coordination with local and international experts. To support the data management plan, the following key concerns were identified for the roadmap development.

- **Key data sectors required:**
  - Raw material extraction: lime, bio-oils (Ayurveda oils), minerals (gems)
  - Agriculture, fishery and forestry: rice, tea, rubber, coconut, cinnamon, fruits and vegetables, dairy, livestock (chicken meat, prawn farms), forestry
  - Manufacturing and service provision: textiles, paints, detergents
  - Energy systems: electricity grid mix, petroleum refinery process
  - Transportation: vehicle emissions (petrol and diesel)
- **Key data-related stakeholders:** NCPC-SL, Sri Lanka Standards Institution (SLSI), Department of Census and Statistics, Ministry of Mahaweli Development and Environment, Central Environmental Authority, Academics/researchers in universities/research institutes, Other government institutes in environmental concerns, LCADeSNet-SL, LCA practitioners in private industries.
- **Data needs and availability:** The country needs of key data sectors (indicated above) were identified based on a prioritization criterion. In first roadmap implementation activities,

data collection working groups will be appointed for each data sector. The appointed data collection groups from universities/research institutes, representative research coordinators, etc. will be guided to conduct background studies for any existing data that can be refined and converted into usable format with acceptable quality for LCI database. For such already available data, a representative from the institutes having available data will also be appointed to the particular data collection group. For new data collections, research projects focused on the specific data sectors will be provided to the corresponding working group according to the data need. These research projects will be guided by NCPCL-SL and funded by the roadmap implementation budget in order to generate new LCA data for the database. The data collection groups will be closely monitored on how they use the provided funding for data collection and whether they use the standard practice for data survey/questionnaire preparation and data quality requirements for the national LCI database.

- **Data collection mechanism:** The data collecting through working groups would be according to the following steps.
  - Develop Terms of Reference (TOR) for the data collection project and questionnaire preparation for the data collection survey.
  - Data collection will be driven by specific LCA aimed studies through university research projects assigned by NCPCL-SL.
  - Data available at authorized departments/institutes will be scrutinized and ensured whether they meet the required quality/other requirements to be adopted into the LCI database.
  - The research projects and required testing for LCI data collection or verification of existing data will be linked with funding of the roadmap implementation.
  - Frequency for updating the database would be within an update cycle of 5 years, including assessment of the status of existing data in every 3 years.
- **Data validation mechanism:** It is required to consider functional, formatting, nomenclature, and documentation requirements to validate a dataset in a database. In consideration of these requirements, a data quality control guideline following up the standard LCA practice has to be established. A group of LCA practitioners with experts in data quality assessment and review will be appointed in line with the data review working committee. After working on the data quality documentation and procedures, the expert committee will have a careful look at the datasets to validate the data before releasing into the database.

For data publication and updating in the database, the concerns are procedures/rules/compatibility with international LCI data formats, interoperability over the Global LCA Data Access (GLAD) network, and plans for further research work in local universities/research institutes to improve data availability and harmonization with the database. In NDWG meetings, the stakeholders selected both ecoSpold2 and ILCD as the suitable international metadata exchange formats. The most commonly used LCA software by LCA practitioners, university academics, and researchers in Sri Lanka are the SimaPro LCA software and the OpenLCA software. As the selected data formats are supported by these LCA software, it can easily promote LCA practice in the country simultaneous to the national database development. Furthermore, preparation of the metadata descriptors for LCI data are required to connect with GLAD. As the first step, the already available national LCI data for tea, rice, and dairy sectors in Sri Lanka are connected with GLAD with the guidance and support from theecoinvent association. The last stage of GLAD connection work is currently ongoing as a part of the data-related activities in the roadmap project. The datasets will be connected to GLAD by selecting a platform allowing storage of both ecospold2 and ILCD metadata formats.

### **3.5.3 Data quality requirements and review**

As mentioned earlier, the collected data must be verified through the database review committee whether they follow the database quality requirements. In data submissions to the database, some data might be missing, or a data source may not be reliable, or a model is needed to be applied instead of actual data. As a result, it is recommended that the information on how much data deviates from the initial quality requirements needs to be transparently documented and available for performing sensitivity and uncertainty analysis in standard LCA practices. The quality requirements of collected data must be developed for the data review purposes to distinguish the data to be inserted into the database.

The data collection plans/procedures are first ensured to provide resulting data with satisfactory quality for the database. For the data collection efforts of the data collecting groups, the sample size of the data survey, the structure of questionnaires, and other methods followed in the data collection process will be closely monitored by the data review committee. Guidelines/quality checking systems are needed to document and assess data quality aspects, for example, geographic, temporal, and technological representativeness, reliability, and completeness of the underlying data used. Sometimes, certain datasets would require a different level of data information and quality. There should be provisions provided in the data quality and review plan to evaluate such data and make availability of the database system for them.

The data quality requirements should be determined based on the scope and intended uses of the database according to the international standards, i.e., ISO, ecoinvent, etc. A possible data quality measure of country-specific LCA studies would be the availability of metadata descriptors and compatibility to connect with GLAD. The specific data format to be used in the national LCA database (i.e. ecoSpold2 and ILCD) are determined according to the interoperability, compatibility, and convertibility through metadata descriptors and nomenclature for proper access to the database.

In the first roadmap implementation activities, the focus will be given to organize already available LCI datasets on tea, rice, and diary sectors and connecting them with GLAD by providing metadata descriptors. Then, new LCI data on other data sectors (i.e., coconut, rubber, cinnamon, transport, fuels, utilities, etc.) can be collected to be inserted in the database. While the data collection is in progress on other data sectors, the attention would be drawn towards providing the required metadata descriptors for the new data sectors and inserting them into the database, simultaneously. These metadata descriptors for each dataset will be in English language and freely available for all users of the database. After providing metadata descriptors at a satisfactory level, interoperability of the new datasets joining the Global LCA Data Access (GLAD) network will be considered. Connection of the existing datasets with GLAD network will provide a better commencement as the first roadmap implementation activities to develop the Sri Lankan LCI database having the interoperability and increased accessibility from the beginning.

## 4 Roadmap implementation plan

The national LCA database roadmap implementation plan should be developed and updated annually by the database hosting organization (NCPC-SL) to guide the database governance and management working groups to plan the work and funding requirements. To support the initial planning, a tentative plan for five-years span was outlined based on the discussions in the NDWG meetings. This plan defines the management structure, including the formation and operation of the steering committee, advisory board, and other working groups, sub-groups. The vision statement, goals of the database development project, maintenance activities for the project, including alternative funding mechanisms, etc. will be explored to streamline this roadmap implementation plan time to time. The major roadmap implementation activities are as follows.

### 1. Approval of roadmap and initial planning to implement

- Disseminating the developed roadmap among wide range of stakeholders and obtain public comments through newspaper advertisement.
- Formally establish the steering committee, advisory board, working groups for IT, review, data collection, and fund raising.
- Development of an operating plan and a business plan, including a well-planned budget.
- Preparation of requests/proposals/ other documentation for fund raising.

### 2. Capacity building and human resources development

- Appointment of data collection sub-groups from universities, research institutes, and industrial LCA practitioners. Then, providing required sessions for trainings and guidelines to collect quality LCI data.
- Providing trainings to IT working group in NCPC-SL on database software platform operations to operate and maintain the database. (Software platform development and trainings will be provided by an outsourced expert)
- Awareness sessions on using the database for potential data users.

### 3. Data collection and review mechanisms

- Prioritization of the identified key data sectors, based on their importance to the country and assign data collection groups for the identified data sectors.
- Developing metadata descriptors for already available data (on tea, rice, and dairy) to connect with the GLAD network. This activity is currently in the last stage of preparing supplemented metadata descriptor files for upload to GLAD.

- Mapping the data quality requirements with LCA approach requirements in national policy making and public policies for sustainability development, such as eco-design, eco-labelling, product carbon footprint, promoting LCA in the local industry, and value addition for already available data sources in the country, i.e., national greenhouse gas inventory database, ongoing formal LCA studies, etc.
- Incorporating new/missing data collected from on-going country-related LCA studies assigned to data collecting research groups for the review process.

#### **4. Establishment of a service providing mechanism for database users**

- Defining the access criteria and financial terms, charges for the database users.
- Updating a website linked to the national LCI database for public access.

#### **5. Development of the IT platform for the database**

- Developing database software applications for data reviewing and tracking for entered data approval by the review committee.
- Inserting the collected and reviewed data into the developed database.

#### **6. Risk identification, ongoing development, and maintenance procedures for the database**

- Identification of the possible risks for the database roadmap implementation.  
There could be many risks when implementing this roadmap. One of the most probable risks would be running out of funding and budget for the implementation plan, difficulty in finding required human resources, unavailability of required data and complexity of available processes for data collection, lack of support from some stakeholders, etc. However, there are already developed datasets with the supervision of the database lead organization (NCPC-SL). Thus, in any case of above risks, the scope of covered datasets could be narrowed, and the work would be focused on the already developed datasets until the required funds are obtained for new datasets development.
- Another possible risk is that the appointed roles in the database governance structure provide low contribution and not attending to the expected responsibilities. To overcome this risk, the lead organization can prepare a legally bound agreement that is signed between each appointment to the governance structure and the lead organization (NCPC-SL).
- Periodic review (every 3 years) for continuous update of the datasets in the database.
- Implementing a communication plan and a mechanism to make awareness among the LCA practitioners in the country and obtain new data generated through their new studies as input data for the LCI database. In this regard, the first national LCA

conference was already held on 31.05.2019. The details are described under the section 4.1: roadmap dissemination activities.

Table 4.1 indicates the tentative timeline of the five-years (60 months) national LCA database roadmap implementation plan.

Table 4.1: Tentative timeline for five-years (60 months) roadmap implementation plan

Roadmap implementation activities	Duration (Months)									
	1-6	1-12	12-18	18-24	24-30	30-36	36-42	42-48	48-54	54-60
<b>1. <u>Approval of roadmap and initial planning to implement</u></b>										
Disseminating the developed roadmap and obtain feedback										
Establish the steering committee, advisory board, working groups										
Development of a business plan with a well-planned budget										
Preparation of requests/proposals/documentation for fund raising										
<b>2. <u>Capacity building and human resources development</u></b>										
Appointment of data collection sub-groups and provide training										
Providing trainings to IT group to operate and maintain the database										
Awareness sessions on using the database for potential data users										
<b>3. <u>Data collection and review mechanisms</u></b>										
Assign data collection groups for the identified data sectors										
Developing metadata descriptors for already available data (on tea, rice, and dairy) to connect with GLAD into the database.										
Incorporating collected data for the review process and validation										

Cont'd Table 4.1

Roadmap implementation activities	Duration (Months)									
	1-6	1-12	12-18	18-24	24-30	30-36	36-42	42-48	48-54	54-60
<b>4. <u>Establishing service providing mechanism for database users</u></b>										
Defining the access criteria and financial terms, charges for users										
Updating a website linked to the LCI database for public access										
<b>5. <u>Arrangement of the IT platform for the database</u></b>										
Preparing the software platform and data templates										
Arranging database software applications for data reviewing										
Inserting collected and reviewed data into the arranged database										
<b>6. <u>Risk Identification, ongoing development, and maintenance procedures for database</u></b>										
Identification of the possible risks for the database implementation										
Periodic review (every 3 years) for continuous update of the datasets										
Implementing a mechanism to make awareness among the LCA practitioners in the country										

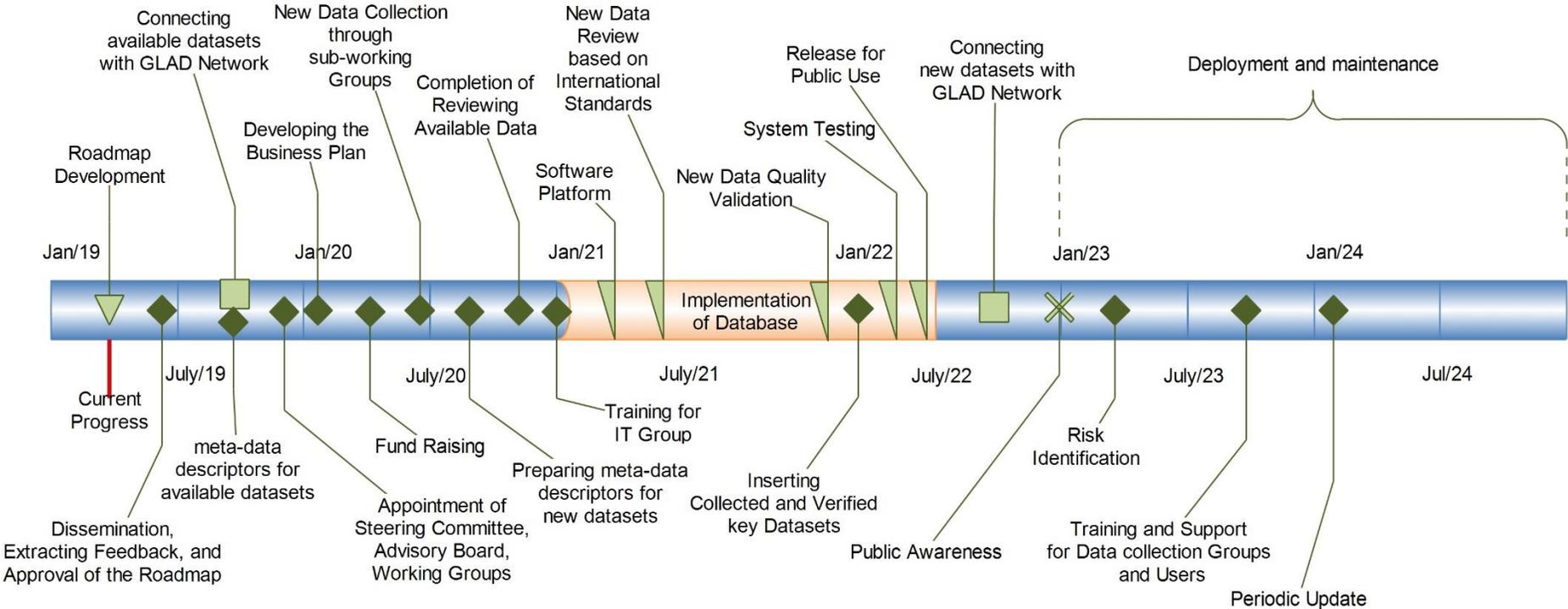


Figure 4.1: Five-Years Roadmap implementation Plan for National LCI Database Development in Sri Lanka



## **4.1 Roadmap dissemination activities**

Few activities have been already taken place in Sri Lanka in order to disseminate the roadmap for the national LCI database development among a wide community of stakeholders. With this intention, the First National Conference on Life Cycle Assessment in Sri Lanka was organized by the National Cleaner Production Centre (NCPC-SL) and it was held on 30<sup>th</sup> May 2019, at Renuka City Hotel, Colombo with many participants representing academia, government institutes, and various industries. The conference created the space for an open exchange of ideas, sharing new concepts, active engagement and network opportunities among the LCA related community in the country. The overall objective of the conference was to promote Life Cycle Assessment among a wider stakeholder group and provide a platform to LCA practitioners to bring forward their experiences in LCA through performed case studies and related past/ongoing activities.

The contents and status of this national LCI database roadmap development project in Sri Lanka were presented to the stakeholder audience in the conference. The key activities of the roadmap project and the proposed roadmap implementation plan were also demonstrated to the conference audience. The conference objectives were successful with the active engagement of the audience and their feedbacks made the LCA roadmap development process also a fruitful one. As a result, dissemination of the roadmap report for Sri Lanka which is an essential component in the roadmap implementation activities was initiated.

## References and resources

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- UNEP. 2007, *Life Cycle Management-A Business Guide to Sustainability*
- <https://www.switch-asia.eu/policy-support-component>
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- US department of energy, *U. S lifecycle inventory database roadmap*, <https://www.nrel.gov>.
- *National Policy on Sustainable Consumption & Production for Sri Lanka*: <http://mmde.gov.lk>.
- *The report on Introducing Eco Innovation and Life cycle approach in Selected Manufacturing Sector*: <http://mmde.gov.lk>.

## Appendix

Table A1: Summary of LCA training programs conducted in Sri Lanka

Year	Description	Organizing body	Resource persons/supporting agent	Outcomes of training program
2005	A national level capacity building five-day workshop on LCA	NCPC-SL	International experts deployed by the United Nations Industrial Development Organization (UNIDO)	Twenty professionals were trained including academics, consultants and industrialists and were given hands on experience on LCA software (training versions).
2013	National level capacity building (5 days) on LCA and eco-design	NCPC-SL	NCPC-SL	Thirty professionals including academics, researchers, industrialists and consultants were trained.
2014	Eco-innovation based on LCA approach training program	NCPC-SL	United Nations Environmental Program (UNEP)-funded project (2014-2016) on eco-innovation carried out by the NCPC-SL	Practical training to industry representatives while eco innovation methodology was implemented in 6 companies. Development of trained resource persons from industry, academia, and government institutions.
2015	Workshop series on national level capacity building on LCA & management	Life Cycle Assessment for Design Sustainability Network (LCADeSNet)	Ministry of Mahaweli Development and Environment through Policy and Planning division in collaboration with, UNEP and Federation of Indian Chamber of Commerce & Industry.	Promoting LCA and Management concepts as a decision-making tool in Sri Lanka by raising the awareness and capacity building among 50 key stakeholders in the state, business, and higher education sectors. A roadmap for promoting LCA was prepared and submitted.
2015	Roundtable discussion on LCA	Life Cycle Assessment for Design Sustainability Network (LCADeSNet)	Dr. Llorenç Milà Canals, Program Officer & Science Focal Point Sustainable Lifestyles, Cities and Industry, Division of Technology, Industry and Economics, UNEP, France	Top officials in the government agencies (ministries, research institutes, members of LCADeSNet) participated and discussed about promoting the use of LCA approach in organizations.

Cont'd Table A1

Year	Description	Organizing body	Resource persons/supporting agent	Outcomes of training program
2016	Training program on “ <i>Life Cycle Perspectives in ISO 14001-2015</i> ”	NCPC-SL	Local resource persons	Scientific officers of the Sri Lanka Standard Institute were trained on ISO standards.
2016	National seminar on “ <i>Life Cycle Assessment and ISO 14001, Management Systems for Sustained Success in 21st century</i> ”	Sri Lanka Standard Institution	NCPC-SL	Fifty management level participants from public and private sector organizations attended the event. The importance of the life cycle approach, and its application in ISO 14001 was the focus of the seminar.
2017	Training of trainers (ToT) on life cycle inventory database development.	NCPC-SL	United Nations’ 10 Years Framework Program (10YFP) of consumer information for Sustainable Consumption and Production (SCP)	Twenty participants were trained for life cycle inventory database development.
2018	Training of trainers (ToT) on developing eco-labels for Sri Lanka.	NCPC-SL	United Nations’ 10 Years Framework Program (10YFP) of consumer information for Sustainable Consumption and Production (SCP).	Twenty-five participants from selected industrialists, consultants, academics, and researchers were trained.

Table A2: National university degree programs related to LCA approach

University	Degree Program	Level	No. of credits	Coverage	Students per batch	Lecturers	Software being used
University of Colombo	Bachelor of Business Administration	3 <sup>rd</sup> year	2 Optional Course	Provide an introduction to LCA concept under the subject "Environment Management"	200	Ms. Sashya Herath	No technical aspects are covered.
		4 <sup>th</sup> Year	2 Optional Course	Provide an introduction to LCT concept under the subject "Supply chain Management"	100		No technical aspects are covered.
			3	An introduction to the concept of LCT under the subject Operational Management	50	Mr. Chandana Wijekoon	No technical aspects are covered.
	Masters of Environment Management	2 <sup>nd</sup> Year	3	Under the subject Environment and Industry Resources, technical aspects of LCA, LCT is discussed.	40	Dr. Sampath Wahala	Until now no software is being used.
University of Sri J'pura	Postgraduate certificate in Corporate Environment			An introduction, why LCA? and applications of LCA	5	Mr. Chalaka Fernando Dr. Randika Jayasinghe	No software is used
University of Kelaniya	BSc. in Environmental Conservation and Management	3 <sup>rd</sup> Year	3	Under the subject Environmental Management Systems and Green Technologies	50	Dr. Priyantha Epa Dr. Rangika Bandara	Till now no software is being used due to unavailability
University of Moratuwa	Chemical and Process Engineering	4 <sup>th</sup> year	4	Under the module Clean Technology	80	Dr. Manisha Gunasekara	No software is used
	Master of Environmental Engineering and Management			Course component – Environmental Management: an introduction, why LCA, wider applications,	~ 40	Mr. Chalaka Fernando	Few examples being explained through GaBi, no modelling

Cont'd Table A2

University	Degree Program	Level	No. of credits	Coverage	Students per batch	Lecturers	Software being used
University of Peradeniya	Chemical and Process Engineering MSc. in Sustainable Built Environment	3 <sup>rd</sup> year		Under the module Environmental Management	25		
	MSc in Environment Management	1 <sup>st</sup> Year		Under the Module Environment Management and Sustainable Development	30	Mr. Jagathdeva Vidanagama	Until now no software is being used.
	BSc. Production Engineering		3	Under the subject sustainable manufacturing, LCA concept is discussed	40	Mr. Jagathdeva Vidanagama	Until now no software is being used.
University of Ruhuna	Bachelor of Science in Green Technology	4 <sup>th</sup> year	2	Life Cycle Assessment	50	Dr. Jayantha Weerarathne	
Sabaragamuwa University of Sri Lanka	BSc. Honors in Eco-business Management	3 <sup>rd</sup> year	3	Industrial Ecology	60	Dr. Sampath Wahala	Open LCA, SimaPro
		4 <sup>th</sup> year	2	Creativity and innovations management			
		4 <sup>th</sup> year	3	Modelling eco business			
	B.Sc. in Environmental Sciences and Natural Resource Management	3 <sup>rd</sup> Year	2	Cleaner Production and Green Productivity	60	Ms. Upendra Arjeewani Weerathunga	Do not use software.
Open University of Sri Lanka	M. Sc in Environment Science	2 <sup>nd</sup> Year	Optional course	Under the subject Cleaner Production	15	Eng. Sena Peiris Ms. Iresha Gurusinghe	Do not use software.

Table A3: Research conferences where some LCA related works were presented

Conference Name	Year	Hosting Institute/ Organization
2 <sup>nd</sup> Sri Lanka Roundtable on Sustainable Consumption and Production	2012	NCPC-SL
International Conference on Sustainable Built Environment (ICSBE)	2017	University of Peradeniya
Vidulka national sustainable energy conference	2017	Sri Lanka Sustainable Energy Authority

## Projects for national LCA approach and LCI data development

### UNEP Eco-Innovation Project (2014-2016)

**National Cleaner Production Centre, Sri Lanka** (NCPC-SL) pioneered the implementation of eco-innovation in Sri Lanka. It has also contributed to the development of the eco-innovation methodology by participating in the initial and second expert group meetings that were held to develop UNEP's eco-innovation methodology and toolkit in 2011 and 2012, respectively. In 2013, NCPC-SL has trained some of its employees through facilitating their participation in the regional training programs on eco-innovation.

Due to its prominent position in the field of eco-innovation in the country, the NCPC-SL received financial and technical assistance from UNEP through 1<sup>st</sup> pilot application of eco-innovation (2014-2016). This pilot project on eco-innovation was implemented in agri-food sector in Sri Lanka. Companies that produce products, such as desiccated coconut, dairy, cinnamon, soy and processed fruit were selected and trained to implement eco-innovation methodology in their companies. A summary of some case studies from the selected companies are presented below.

- Asian Agro, SME from Kochchikade, used to produce desiccated coconut with high levels of waste generation and energy consumptions. Through eco-innovation, the company now produces virgin coconut oil with higher profits and export potential while minimizing wastes and diversifying to new product lines.
- "Rasoda Dairies", a dairy business previously hampered due to lack of technology, low supplier productivity and high waste, has used eco-innovation to move from a production-centric business model to a partnership-oriented approach. With farmer development underpinning its eco-innovations, Rasoda has increased milk yields and energized its value chain, forming multiple supplier partnerships in the process.
- "Convenience Foods", producers of vegetable protein and other foods, used the eco-innovation process to address a range of "hotspots"; including low product efficiency, high import dependency and government packaging regulations. Now the company is well on the way to, a new "green-conscious" product line using locally-sourced soy, and strong partnerships with local farmers.

- Before introducing eco-innovation, “Ceylon Commodities & Consultants” which processes and exports cinnamon from Sri Lanka’s Southern province were faced with a range of problems, such as low product quality, high wastages, demotivated workforce and a series of environmental issues. Because of eco-innovation, the company is now introducing multiple solutions, including sustainable business practices, product diversification and eco-tourism to promote the brand.
- “Jachufi”, a fruit-based Industry, a specialist in fruit processing, used a range of tools including life cycle thinking to develop a new business model and became a fruit pulp supplier for bigger brands. The company plans to be a distributor of pulp and juice to customers adopting a service-oriented business model with life cycle thinking.

### **SWITCH-Asia Sustainable Consumption and Production (SCP) National Policy Support Component for Sri Lanka (2015-2019)**

The overall objective of this project is to support the Sri Lankan Government in selecting, adapting and implementing suitable economic and regulatory policy instruments to promote SCP, thereby enhancing the long-term sustainability of consumption and production patterns. The project functions under the Ministry of Mahaweli Development & Environment (MoMDE). This project is funded by the European Union. As a key outcome of this EU-funded project, a National SCP Policy has been developed for the country. This is an overarching national policy in Sri Lanka on SCP, which is coherent and integrated with related sectoral policies, to achieve the desired goals of economic and sustainable development in the country. (<http://mmde.gov.lk:National Policy on Sustainable Consumption & Production for Sri Lanka>). The developed SCP policies related to LCA approach are summarized as follows.

#### **(i) Science and Technology Policy**

##### ***Policy principle***

Science & Technology (S&T; and Research and Development, R&D) based on Life-Cycle Thinking, recognized as precondition for sustainable development.

##### ***Policy statements***

- a) Create an enabling innovation culture on SCP among all sectors.
- b) Develop and promote appropriate resource efficient technologies (Eco-innovation / environmentally sound technologies) relevant for different sectors ensuring sustainable consumption & production of goods & services.
- c) Ensure S&T achievements on SCP readily accessible to industries and the public
- d) Encourage technology transfer, application of resource efficient technologies for commercialization through Public Private Partnerships (PPP).
- e) Document, publish and promote science-based-evidence to foster indigenous knowledge on SCP in all sectors.
- f) Develop knowledge base for Life Cycling Thinking and apply LCA to promote clean and safer products over the value and supply chains.
- g) Provide technical guidance for retailers, consumers and producers for behavioral and lifestyle changes ensuring improvements in use efficiency.
- h) Ensure quality assurance of green products and services.

- i) Provide technical evidence, education and awareness on SCP best practices to motivate consumers to make attitudinal, behavioral and lifestyle changes towards sustainability.
- j) Apply ICT for technology banks, awareness, promotion and networking of all sectors.

### **Policy goals**

- a) Streamlining of life cycle approach to industries facilitated
- b) SCP principles incorporated into product design processes
- c) Mechanism to share science & technology achievements with industries established
- d) Green label standards introduced to industries, retailers and consumers
- e) Methodologies introduced for resource pricing
- f) Methodologies introduced to value biodiversity and eco-system services
- g) ICT enabled technology banks established and networking introduced
- h) Key Performance Indicators (KPI) established to evaluate progress achieving SCP
- i) National scheme to recognize SCP achievements, with progressing levels (bronze-silver-gold)

### **(ii) Public procurement policy**

#### **Policy principles**

Sustainable Public Procurement properly understood and applied.

#### **Policy statements**

- a) Build capacity and empower public sector establishments on Sustainable Public Procurement (SPP).
- b) Apply Sustainable Public Procurement Practices (SPP) in all relevant sectors and for each product that have a significant impact.

#### **Policy goals**

- a) Administrative and legislative framework established for the promotion of Sustainable Public Procurement (SPP) in relevant sectors before 2020.
- b) Life cycle databases for key product categories with significant environmental impact either created or updated by 2025.
- c) Implementation of SPP ensured at least in 5 major product categories, in relevant sectors that have a significant impact, before 2020, at least 50% of product categories by 2030.

### **UN 10 Years Framework Program (10YFP) Consumer Information for Sustainable Consumption and Production (SCP) (2017-2019)**

With the successful completion of the aforementioned UNEP-funded Eco-innovation project, NCPCL-SL managed to secure funding from the UN 10YFP's Consumer Information Program to implement a project on "*Promoting SCP in Sri Lanka through facilitating accessibility to information*". The project focuses on creating synergies among eco-innovation, life cycle thinking, green public procurement (GPP) and other SCP concepts. Major activities of the project are;

- Developing national Life Cycle Inventory (LCI) datasets for agri-food sector (rice, tea, and dairy processing industries)
- Developing a green product certification scheme for a selected dairy product category and assisting two companies to adopt eco-innovation (potential/eventual replication)
- Assessing and increasing consumer awareness on sustainability issues, use of information and available green product certification.

Table A4: Some LCA studies on products and services in Sri Lanka

Service provider	Industry	LCA approach
NCPC-SL	Fabric dye	LCA
	Textile	Water Footprint calculation, Product Carbon Footprint
	Tea	Product Carbon Footprint
	Food Processing	Water Footprint Carbon Footprint calculation
	Rubber	Water Footprint Carbon Footprint calculation
	Tourism sector (Hotels)	Carbon Footprint calculation Water Footprint
Carbon Consultancy Company	Tea	Product Carbon Footprint
	Apparel	Product Carbon Footprint
	Rubber	Product Carbon Footprint
	PET Bottles (water)	Product Carbon Footprint
Leiden University	Rubber Gloves	Social Life Cycle Assessment