

CHAPTER III EXPERIMENTAL

3.1 Materials and Equipment

Equipment:

Desktop, Intel® Core™ 2 Duo CPU E6750 2.66 GHz, 2.95 GB of RAM

Software:

- LCSofT
- ECON
- SustainPro
- SimaPro

3.2 Experimental Procedures

The framework consists of four main tools, Tool 1, Tool 2, and Tool 3 are dedicated to the improvement of LCA software, LCSofT and Tool 4 is dedicated to software integration (see Figure 3.1).

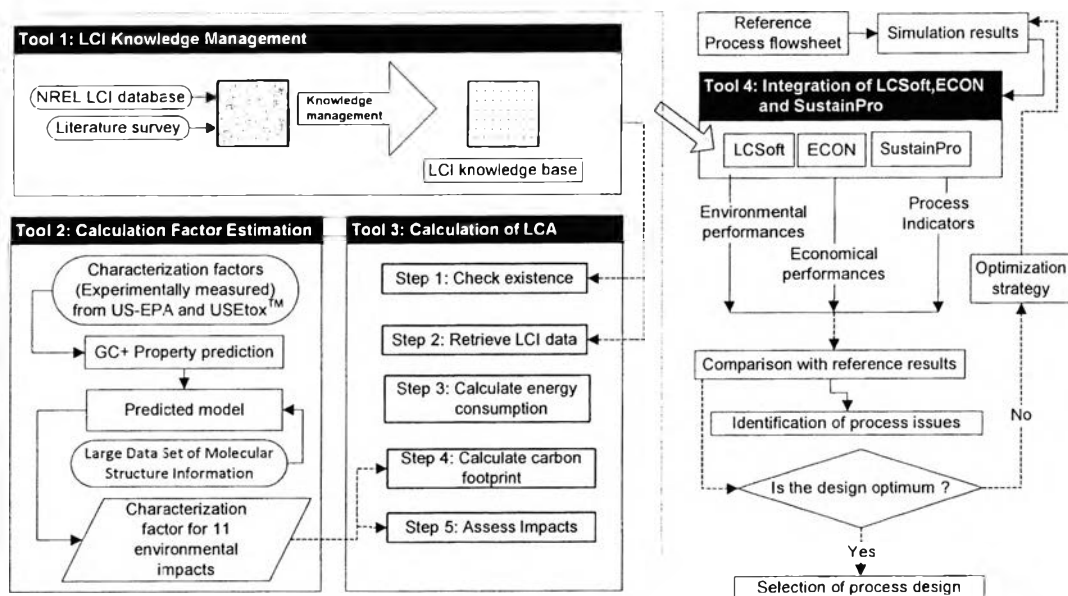


Figure 3.1 The framework of LCSofT and software integration

3.2.1 Tool 1: LCI knowledge management

LCI data inputs and outputs can be separated into the smallest portion of a product system for which data are collected when performing a life-cycle assessment called a unit process. The unit process can be composed of other processes, for instance: tank production can be composed of steel production. A unit process is a specific stage of LCI data. Inputs and outputs in LCI data from US LCI (U.S. Life Cycle Inventory Database, 2012) and other literatures compose of several processes and data linked together through an input/output interface. Therefore, with this tool, the knowledge representation in LCI data is managed through a specially developed ontology of the system information, enabling easy maintenance and future expansion of the LCI database.

3.2.2 Tool 2: Calculation factor estimation

Characterization factors (CFs) of some complex chemicals are not available and many of them have the potential to damage the environment. Tool 2 is based on the group contribution⁺ method (GC⁺). LCSOFT database contains data from the USEtoxTM and the US Environmental Protection Agency (EPA) and especially developed predictive property models (Hukkerikar *et al*, 2012), characterization factors of 11 environmental impacts are estimated.

3.2.3 Tool 3: Calculation of LCA

There are two main steps in this tool; (i) inventory calculation, this step performs an inventory of retrieved data from the LCI database to calculate resource consumption and to prepare for the calculation in the next step; and (ii) classification characterization, this step classifies and characterizes the types of the environmental impacts and calculates them with respect to substances emitted from the life cycle of product or process and their characterization factors for each impact category, carbon footprint and other environmental impacts are calculated. Results (resource consumption, carbon footprint, and environmental impacts) will be analyzed in order to decide on the environmental improvement options.

3.2.4 Tool 4: Integration of LCSOFT, ECON and SustainPro

LCSOFT is integrated with ECON and SustainPro to obtain all the necessary performance measures to analyze a design alternative. This tool provides

options to enter process evaluation data (LCA, economic analysis, and process sustainable analysis) and perform process evaluation and retrieve results.

3.2.5 Validation of LCSOft version 2.0

The upgraded LCSOft was tested with a bioethanol production process from cassava rhizome (Mangnimit, 2012), mass and energy flows are taken from the simulation results which are developed according to NREL study. Environmental impacts, and energy consumption calculated from LCSOft are compared with commercial LCA software, SimaPro.

3.2.6 Write manual

- LCSOft version 2.0
- Tool 4 (Interface of LCSOft, ECON, and SustainPRO).