

Corporate Environment Sustainability Model from Life Cycle Assessment of Hard Disk Drive

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Abstract— This research studies the guideline of applying analysis of the environmental impact by using Life Cycle Assessment (LCA). The guideline from Life cycle Assessment leads to Eco-design which is a tool to develop environmental friendly products. Eco-design was analyzed with Sustainable Development (SD) which the economy, social, and environment are equally important.

The results from Corporate Environment Sustainability model may be a guideline for organizations to assess the impact of their business on three important fields; economy, social and environment. The Sustainable Development will provide guideline for business management as a green organization which leads to development of green marketing.

Keywords— Life Cycle Assessment (LCA), Sustainable Development (SD), Green Organization

I. INTRODUCTION

Improvement or alternatives of production process to reduce impact to the environment and green organization management are processes and ideas that encourage balanced management between producing and using resources. The 10th Improvement of Economy and Social National plan indicates that one of the main strategies is to develop diversities in biological and to strengthen natural resources and environment bases. Adjustment of production plan and behaviour to reduces effect on natural resources and environment bases is a sustainable consumption and leads to sustainable production.

This research uses Life Cycle Assessment (LCA) which is a technique based on scientific and quantitative data. This makes it suitable using it as a reliable tool to compare or support decisions. LCA considers everything that enters the

cycle which covers obtaining resources, designing, production, transportation, product usage, reuse and waste management after expiration (Cradle to grave). Energy, resources, and pollution from product are considered in order to improve the product and the production process to have the lowest impact to energy, environment and natural resources. LCA can be used as a guideline for Eco-designing to design environmental friendly products. Eco-design is combined with Sustainable Development (SD) to balance economy, social and environment. These three main factors have other minor factors that need to be considering such as increase of productivity, increase of production quality, waste reduction, and cost reduction by using Eco-design. That will reduce resources but will increase the quality of working process such as the production. Quality of social is measured by Happy Workplace which contains sub factors of work, culture, leadership and other sub factors inside and outside of the organization. Most of the activity is for the surrounding society such as forest plantation, building dams and increase knowledge of the society. Environment factors and mainly based on LCA such as 1) Green house effect 2) reduction of ozone layer 3) water and air pollution 4) acidity effect 5) energy usage 6) toxicity to nature. Eco-design will use these factors to use resources to have the highest benefits. These factors are also known as impact factors. The factors leads to quantity assessment and Corporate Environment Sustainability model resulting in increases of competitiveness of Hard Disc industry of Thailand.

II. METHODOLOGY/EXPERIMENTAL DESIGN

1. Life cycle Assessment (LCA) [1], [2], [5]

LCA is studied following the four steps from ISO14040; goal and scope definition, inventory analysis, impact assessment and interpretation. (Figure 1)

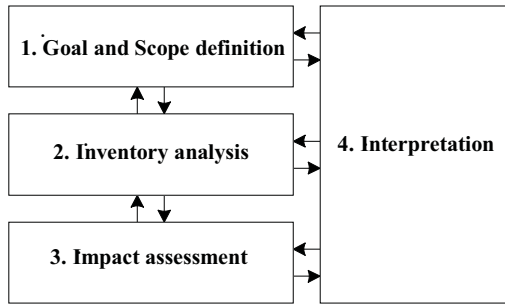


Figure 1: The four steps in LCA

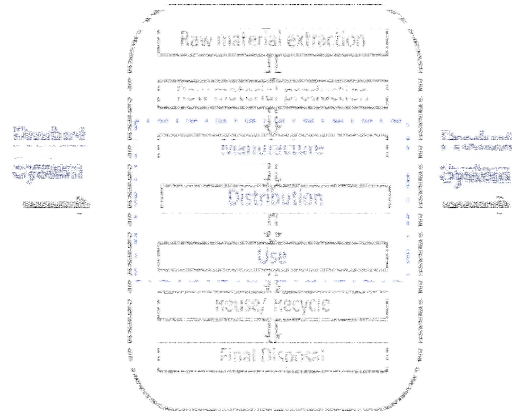


Figure 3: The LCA scopes of Hard Disc Drive

1.1 Goal and Scope definition

1.1.1 Goal definition

- Assess environmental impact of Hard Disc Drive by LCA
- Greenhouse Gas and Carbon Footprint are measured to find out which process release highest Carbon Footprint and design to reduce Carbon Footprint
- Analyse ideas in corporate environment sustainability model in green organization management

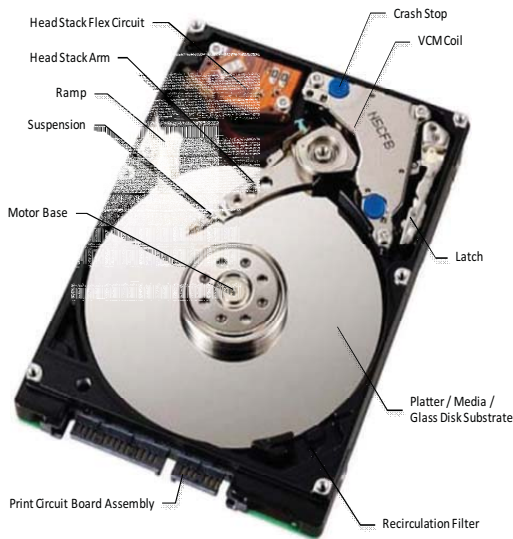


Figure 2: Hard Disc Drive parts

1.1.2 Units of the study

Units of the study were set to use as a basis to set data collection of input and output of the interested system. The functional unit (FU) in this study is a 2.5 inches Hard Disc Drive with a life span of four years that is used in portable computer (Figure 2).

1.1.3 Scope definition of LCA

- The scope of study is the Hard Disc Drive impact to environment from greenhouse gas and carbon footprint. The assessment begins from the production, transportation and using of the product (Figure 3). The life cycle is divided into 3 steps 1) product assembly. 2) Transportation 3) usage of Hard Disc Drive as a main component in portable computer. Each step will be explained in list analysis
- The environmental impact that was chosen to study is 1) Green house effect 2) reduction of ozone layer 3) water and air pollution 4) acidity effect 5) energy usage 6) toxicity to nature. These are the environments that cause lot of problems in Thailand.
- Carbon footprint will be applied into two approaches; science and green organization business management which the details is as followed.

-Approach 1 (Science) Find the way to reduce Carbon Footprint at the point that produce most Carbon Footprint.

-Approach 2 (green organization business management) Ideas of designing corporate environment sustainability model

1.1.4 Hypothesis and limitation in this research

LCA requires a large database that Thailand did not have. Therefore resources for making Hard Disc Drive are imported from abroad. Abroad database are acquired from Eco-invent

2.0 from SimaPro 7.1 which is an instant program used for assessment of environmental impact. Therefore, in this research some data that are not collected in Thailand will be from abroad such as research data and journal. [3]

1.2 Inventory Analysis

This step includes collection of data that is involved with the environment from each step in goals and scope definition and calculation of inputs and outputs of the product system. The details are as followed.

1.2.1 Manufacturing of Hard Disc Drive parts

This step begins from combining the Hard Disc Drive and packaging. The data was kindly provided from the large Hard Disc Drive manufacturing company of Thailand. The resources, energy and waste are from one Hard Disc Drive (Figure 4).

1.2.2 Usage

The objective of Hard Disc Drive is to collect permanent data such as the performance system, software system, programs and data in the computer. In this research, usage means the steps using Hard Disc Drive compartment in portable computer in offices base on the length of product warranty.

1.2.3 Transportation

In this research, transportation is transport of Hard Disc Drive to sell. The data was kindly provided from the large Hard Disc Drive manufacturing company of Thailand, by SimaPro 7.1 program and truck transportation database of Thailand. Data are calculated by vehicle type, distance and transport weight.

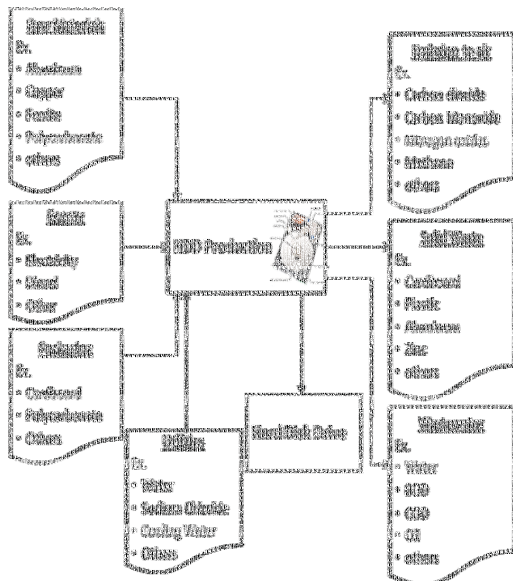


Figure 4: Example of inputs and outputs of Hard Disc Drive manufacturing

1.3 Assessment of Impact

The assessment of environmental impact of product from resources and inputs-outputs from Inventory Analysis step are very important. Classification of groups and comparing impacts are done to prepare information to interpret impact on the environment from production step.

Data from the list resources and energy throughout the usage of a Hard Disc Drive in its lifespan is used to calculate for environmental impact by SimaPro 7.1. IPCC 2007 contains classification of environmental impacts and characterization of each group. [4]

1.4 Interpretation

Interpretation makes us understand the guideline in reducing the impact to the environment of a product. We can identify which process cause the highest impact on environment and should be adjusted to create a better environment.

1.4.1 Life Cycle Assessment (LCA) is a technique based on science and quantitative data and is used as a tool to compare or support reliable decisions which will consider inputs to the system such as energy and natural resource.

The guideline leads to development of the manufacturing process to have higher quality or more alternatives to reduces impact to the environment. Green organization management in the marketing direction by using LCA leads to Eco-design which is a tool to develop environmental friendly products. [8], [9]

Eco-design main idea is to design for environment and is divided into

- 1) Design to save resources
- 2) Design for saving energy
- 3) Design for packaging
- 4) Design for recycle
- 5) Design for disassembly

1.4.2 Sustainable Development (SD)

The definition of Sustainable Development (SD) by World Business Council Sustainable Development (WBCSD) is the development that response to present people and must not affects the needs of future people. New organizations need sustainable development because global climate change and natural resources are nearly depleted. Also factory expansion will lead to reduction of half of the forest especially in China. Sustainable Development (SD) composes of balanced economy, social and environment. These three parts have sub-factors to be considered. Economy will be interested in results from Eco-designing to reduce cost and increase the sales. The socials will consider Happy Workplace theory which composes of work culture and other factors). Lastly environment cares about LCA 1) Green house effect 2) reduction of ozone 3) water and air pollution 4) acidity effect 5) energy usage 6) toxicity to environment. These lead to Eco-design that focuses on using resources to give the highest benefit. These impact factors finally lead to corporate environment sustainability model which increase

competitiveness of Thailand Hard Disc Drive. These will result in having environmental friendly products

1.4.3 Mathematics tools for business decision

Lots of mathematics tools that were used to analyse impact factor are available such as Decision tree model, AHP, Fuzzy. We have selected the suitable tool for this research.

III. RESULTS AND DISCUSSION

This research will aid in finding the environment impact, Green house gas and Carbon Footprint. Also, it can lead to a guideline in reducing energy used and environmental impact of Hard Disc Drive which can be applied to organizations as followed.

-Increase competitiveness from Life cycle Assessment.

The environmental impacts and Carbon Footprint from Life cycle Assessment leads to improvement in production process or alternatives. This includes business management as green organization, for instance, Green marketing and able to compete in Non-Tariff Barrier (NTB).

- Life Cycle Inventory Database of inputs and outputs will be obtained which provides information for applying LCA to Hard Disc industry, such as Eco-design, Carbon Footprint, Eco-Label, and Sustainable Product.

-The company can adapt the concept and results from Life Cycle Assessment, Greenhouse Gas and, Carbon Footprint in advertisement. By building environmental friendly stores, green society, and Eco-efficiency attitude, consumers will realize the values of the product to the environment in the long run. [6], [7]

As for the concept of Corporate Environment Sustainability model, the process of obtaining begins with three related factors; economy, social and environment. The impact factors are shown in figure 5 and figure 6 Corporate Environment Sustainability model (Figure 5)

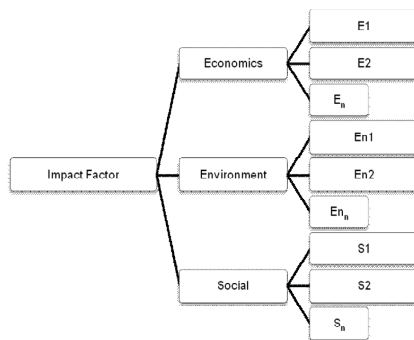


Figure 5: Examples of impact factors from three factors; economy, social and environment. (E1, E2, En, En1, En2, Enn, S1, S2, Sn) are Impact assessment

The function of each impact factors

$$F(\text{Impact factors}) = \text{Impact factors}(\text{Economic}) \theta \text{Impact factors}(\text{Environment}) \theta \text{Impact factors}(\text{Social})$$

Impact factors' functions from economy, social and environment factors. θ is Operator function

When the impact factors functions enters the Business decision, it will leads to Corporate Environment Sustainability model (Figure 6). In this step, we are studying the best tool to use in this research.

$$F(\text{Green level}) = F(\text{Impact factors}) \theta F(\text{Business Decision})$$

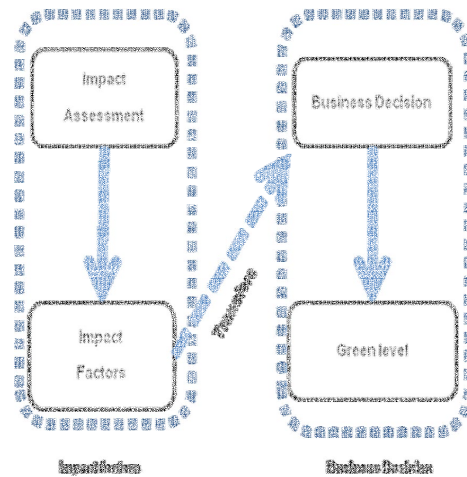


Figure 6: Corporate Environment Sustainability model

Corporate Environment Sustainability model will be a guideline for organization in assessing the impact of business to social, economy and environment under Sustainable Development. The guideline will improve green production processes or green production alternatives and business management as a green organization. The global market is more concerned does not only considers the quality and the costs of product but the environment is also a factor that is used to restrict market.

IV. CONCLUSION

Organizations with business management as a green organizations leads to balances in creating and using resources in a Sustainable Development way and increases in competitiveness. Presently the world does not only pay attention to the quality process and its costs, but also to the impacts on the environment. The factors have been assessed for their impact on each part of the business; economy, social and environment by using Corporate Environment Sustainability model. This is done by using the guideline obtained from Life Cycle Assessment (LCA) in cooperated with Sustainable Development (SD)

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REFERENCES

- [1] Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow, “Handbook on Life Cycle Assessment”, Print: Kluwer Academic Publishers. Page.19-97(2002)
- [2] G. Rebitzera,* , T. Ekvallb, R. Frischknechtc, D. Hunkelerd, G. Norrise, T. Rydbergf, W.-P. Schmidtg, S. Suhh, B.P. Weidemai, D.W. Penningtonf, “Review Life cycle assessment Part 1: Framework, goal and scope definition, inventory analysis, and applications”, *Environment International* 30 (2004) 701– 720
- [3] European Commission. 2010. *Tool SimaPro 7* [Online]. Available: <http://lca.jrc.ec.europa.eu/> (2011, January 25)
- [4] IPCC. 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, in: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., M.Tignor, Miller, H.L. (Eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- [5] Luc Gagnon, Camille Belanger, Yohji Uchiyama., “Life-cycle assessment of electricity generation options: The status of research in year 2001: *Energy Policy* 30 (2002) 1267–1278
- [6] Luca De Benedetto, Jir Klemes, *The Environmental Performance Strategy Map: an integrated LCA approach to support the strategic decision-making process, 2009*
- [7] Helias A. Udo de Haes, Reinout Heijungs, *Life-cycle assessment for energy analysis and management, 2007: Applied Energy* 84 (2007) 817–827
- [8] S. Vinodh, Gopinath Rathod, “Integration of ECQFD and LCA for sustainable product design”, *Cleaner Production* 18 (2010) 833–842
- [9] M. Hauschild , J. Jeswiet , L. Alting, “From Life Cycle Assessment to Sustainable Production: Status and Perspectives”