 https://doi.org/10.1051/matecconf/202237205005

A Desk Study Based on SWOT Analysis: An Adaptation of Life Cycle Assessment (LCA) in the Pulp and Paper Industry

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Abstract. Today, the industrial world is experiencing intense competition with challenges related to environmental issues, and the domestic paper industry is no exception. This study is a follow-up of the research conducted by Palupi et al. (2015) at Company X which, through an LCA study, found an acute water ecotoxicity value of 7.16 kPt, a chronic water ecotoxicity value of 6.5 kPt, and a soil human toxicity value of 2.69 kPt. However, that study did not come with a SWOT matrix. Therefore, using a desk study, the present study aimed to map a SWOT matrix. A desk study based on SWOT analysis from 12 international journals and two national journals sourced from Elsevier, IWA Publishing, MDPI Publisher, Taylor & Francis, and Garuda was used to determine the SWOT matrix. Desk studies have the objective of comprehensively evaluating published journal articles, books, and other sources on given problem domains. Based on the results of the study, some recommendations for actions on the internal and external factors of the company are offered, consiting of steps for the company to mitigate identified weaknesses and threats. This study found that most of the pulp and paper industry engaged in internal strengths and external opportunities and faced numerous internal weaknesses and external threats. Currently, Company X occupied the first quadrant (Growth), indicating that the company was in a highly profitable condition. The company was enjoying many strengths and opportunities. Therefore, it is critical for the company to use its strengths to capture opportunities to minimize its emissions to the environment and to implement LCA in the company.

Keywords. Paper Industry, Reverse Logistics, Life Cycle Assessment, Desk Study, SWOT Analysis

1 Introduction

Recently the industrial world is facing intense competition, with challenges related to environmental issues [1][2][3][4][5][6][7][8]. All manufacturing industrial sectors, including the paper industry, strive to optimize materials processing in order to minimize the generation of new waste for increased market competitiveness [9] [10]. As reported by the World Bank, the total amount of MSW (municipal solid waste) generated globally in 2016 was 2 billion tons, while paper waste amounted to 17% of that, or 340 million tons, per year [11] [12]. Seven earlier works by [13], [14], [15], [16], [17], [18], and [19] have similarly raised the issues of the greenhouse gas effect, global warming, and ozone depletion as a result of paper industry activities.

Reverse logistics can be defined as a process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. This process can be classified into four options, namely, direct reuse, landfilling, recycling, and remanufacturing [20]. It therefore constitutes a part in the sustainable development concept, and it is seeing its implementation at the corporate level [21][22][23][24].

In this research, a desk study based on SWOT analysis in relation to environmental issues in the pulp and paper industry was conducted with a consideration of the life cycle assessment (LCA) of a previous research work to offer some recommendations pertaining to the success of LCA implementation at Company X (a paper company). Therefore, this research was focused on figuring out the strengths, opportunities, weaknesses, and threats faced by Company X in implementing LCA in the paper industry.

2 Literature Review

2.1 Supply Chain Management

A supply chain is a network of companies that work together to create and deliver a product to end users. These companies typically consist of suppliers, factories, distributors, shops or retailers, and supporting

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companies such as logistic services providers. Along a supply chain, there are three types of flows. The first type is the flow of goods from an upstream point downstream. The second type is the flow of cash or its equivalent from a downstream point upstream. The third of the three is the flow of information that can be either from an upstream point downstream or the other way around [25]. An effective coordination along the supply chain plays an important role in the innovation, flexibility, and rate of an industry or organization [26] [27]. With integrated supply chain management, the relationship between the supply chain and the company may see minimized total costs that consist of raw material cost, transport cost, facility cost, production cost, and inventory cost, among others [28] [29][30].

2.2 Reverse Logistics

Reverse logistics is a process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal [20]. Reverse logistics (RL) has been defined as a term that refers to the role of logistics in product return, recycling, material replacement, material reuse, waste disposal, and repair [21] [31]. It has an object along with its basic elements and associations among them, and then there is this reverse pyramid [32]. A reverse logistic process has a focus on the recycling of excess or discarded household products [33].

2.3 Life Cycle Assessment (LCA)

Life cycle assessment (LCA) is one of the techniques to assess and evaluate (sustainable) environmental impacts quantitatively by considering all aspects of resource use, environment, and product at various points in the life cycle [34][18][2][35]. LCA is capable of effective analysis by connecting resources, environmental impact, and product system impact to the manufacturing process, hence yielding a process output that has the most significant change impact on the environment [36][7]. LCA can also compare scenario feasibility and determine efficient chain activities, helpful in establishing a better product [19][37]. An LCA methodology comprises defining the goal and scope, analyzing the inventory, assessing the impact, and assessing the improvement [17]. LCA has become an approach to answering change-oriented questions to support decision making, such as, in policy on product life-cycle environmental management [38][16].

2.4 SWOT Method

SWOT analysis is a strategic planning method to evaluate influencing factors in the attempt to accomplish a goal, namely, strengths, weaknesses, opportunities, and threats, both in the short term and in the long term. In general, SWOT analysis is presented in a table on a large piece of paper to ease the analysis of the relationship between the aspects, involving specific business goals and identification of internal and external factors to accomplish such goals [39].

2.5 Pulp and Paper Industry

The paper industry is considered a mature industry, where the products and production are at a stable state and the competition between companies is mainly confined to cost management. The pulp and paper industry, however, has a considerable potential to cause environmental damages at various stages in the product life-cycle, such as, in forest management, pulp production, pulp bleaching, paper production, and waste management, among others. The waste management methods applied in the paper industry include recycling, energy recovery, and final waste disposal. Therefore, reverse logistic operations have a significant value in the paper industry [6].

3 Research Methodology

This article adopted the desk study approach based on SWOT analysis to figure out the strengths, opportunities, weaknesses, and threats faced by Company X in implementing LCA in the paper industry. A desk study is a search of information from main sources such as published journal articles, conference papers, analysis reports, books, and other publications. The aim of a desk study is accomplished by comprehensively evaluating published journal articles, books, and other sources on a given problem domain. Below is the flowchart of the research conducted.

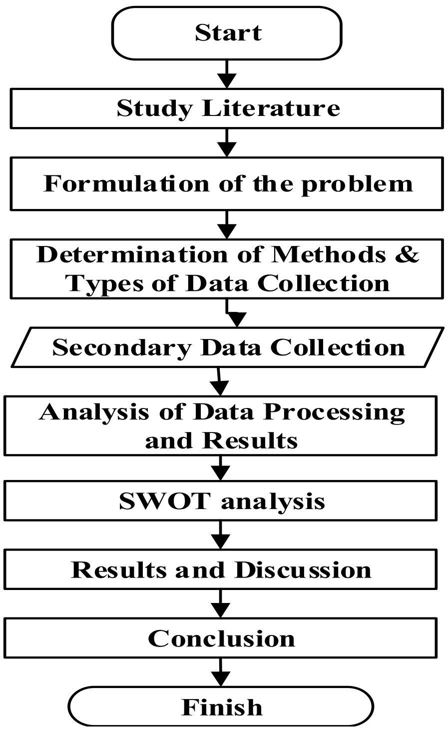

Fig. 1. Methodology Flowchart.

4 Discussion

This section focuses on SWOT analysis in detail to identify the strengths, opportunities, weaknesses, and threats faced by Company X in implementing LCA in the pulp and paper industry. All strengths, opportunities, weaknesses, and threats were formulated by considering the problem domain from various pieces of literature.

Table 1. Strengths in LCA Integration in the Pulp and Paper Industry.

REFERENCES	NO	STRENGTHS
[19] [18]	S1	A growing interest in the paper industry in the implementation of LCA for measuring greenhouse gas emissions
[1] [8]	S2	An implementation of the life-cycle assessment (LCA) method for evaluating the environmental performance
[19]	S3	An intention to identify economic prospects and greenhouse emissions in the context of sub-standard recycle vendor integration
[1]	S4	An intention to present an initial LCA study on paper production waste using the “gate-to-gate” life-cycle
[7]	S5	An implementation of LCA-AHP as a basis for measuring the paper industry performance
[40]	S6	A method recommended by the European Commission for an Environmental Footprint Guidelines for paper products
[40]	S7	LCA calculation within a given time period giving consistent results for the determination of stages in a paper waste life-cycle

Table 2. Weaknesses in LCA Integration in the Paper Industry.

REFERENCES	NO	WEAKNESSES
[8] [41] [40]	W1	A need of representative, accurate, and high-quality data and of periodic updates in the LCA method
[40]	W2	A high amount of time needed in the implementation of LCA calculation to one of a line of products
[42]	W3	Difficulties faced by non-expert organization staff to effectively interpret LCA results
[16]	W4	Static marginal technologies’ incapability to accurately measure LCA results
[19]	W5	Most of resource waste and greenhouse gas emissions is caused by low life-cycle levels as in China.
[41]	W6	Although two products are paper products, different factory configurations may entail a significant difference in pulp/paper-making technologies with different life-cycle environment footprints.
[18]	W7	Low-carbon energy conversion is inapplicable in the short term due to limitations in equipment and funding.

Table 3. Opportunities for LCA Integration in the Pulp and Paper Industry.

REFERENCES	NO	OPPORTUNITIES
[7] [2] [16]	O1	LCA can minimize negative environments that can cause mental problems during the manufacturing process.
[19] [2] [43]	O2	Solution to paper recycle problems such as transport, water balance, and energy
[18]	O3	Proposal of ways of achieving reduced emissions in the paper industry
[18]	O4	Advantages of evaluating greenhouse gas emissions from a paper-making industry chain
[13]	O5	Being helpful in identifying previous research trends and providing a benchmark
[2]	O6	Clear, complete system chain data useful to increase the accuracy of the LCA method

Table 4. Threats to LCA Integration in the Pulp and Paper Industry.

REFERENCES	NO	THREATS
[18] [13] [17] [41] [8]	T1	The paper industry is categorized as an industry heavy in greenhouse gas emissions and ozone depletion.
[2] [44]	T2	Chronic water ecotoxicity results in a side effect on the water ecosystem from the substances produced.
[19]	T3	A contradiction between increased development and paper industry waste life-cycle level as in China
[18]	T4	Failures to achieve the greenhouse gas emissions reduction target as a result of rapidly increasing pulp and paper production
[19]	T5	Difficulties in establishing a management system as most companies in the paper recycle industry are small, scattered sellers
[42]	T6	There is a corporate sustainability target in the global environment trend and a change in environment-label-specific regulations.

STRENGTHS — **Internal** — ***WEAKNESSES***

S1. A growing interest in the paper industry in the implementation of LCA for measuring greenhouse gas emissions
S2. An implementation of the life-cycle assessment (LCA) method for evaluating the environmental performance
S3. An intention to identify economic prospects and greenhouse emissions in the context of sub-standard recycle vendor integration
S4. An intention to present an initial LCA study on paper production waste using the "gate-to-gate" life-cycle
S5. An implementation of LCA-AHP as a basis for measuring the paper industry performance
S6. A method recommended by the European Commission for an Environmental Footprint Guidelines for paper products
S7. LCA calculation within a given time period giving consistent results for the determination of stages in a paper waste life-cycle

W1. A need of representative, accurate, and high-quality data and of periodic updates in the LCA method **(Recommended action O5)**
W2. A high amount of time needed in the implementation of LCA calculation to one of a line of products **(Recommended actions S5 & O3)**
W3. Difficulties faced by non-expert organization staff to effectively interpret LCA results **(Recommended action S7)**
W4. Static marginal technologies' incapability to accurately measure LCA results **(Recommended action S4)**
W5. Most of resource waste and greenhouse gas emissions is caused by low life-cycle levels as in China/ **(Recommended actions S1 & O4)**
W6. Although two products are paper products, different factory configurations may entail a significant difference in pulp/paper-making technologies with different life-cycle environment footprints. **(Recommended action S2)**
W7. Low-carbon energy conversion is inapplicable in the short term due to limitations in equipment and funding. **(Recommended action O2)**

OPPORTUNITIES — **External** — ***THREATS***

O1. LCA can minimize negative environments that can cause mental problems during the manufacturing process.
O2. Solution to paper recycle problems such as transport, water balance, and energy
O3. Proposal of ways of achieving reduced emissions in the paper industry
O4. Advantages of evaluating greenhouse gas emissions from a paper-making industry chain
O5. Being helpful in identifying previous research trends and providing a benchmark
O6. Clear, complete system chain data useful to increase the accuracy of the LCA method

T1. The paper industry is categorized as an industry heavy in greenhouse gas emissions and ozone depletion. **(Recommended actions S1 & S3)**
T2. Chronic water ecotoxicity results in a side effect on the water ecosystem from the substances produced. **(Recommended actions S2 & O2)**
T3. A contradiction between increased development and paper industry waste life-cycle level as in China **(Recommended actions S7 & O5)**
T4. Failures to achieve the greenhouse gas emissions reduction target as a result of rapidly increasing pulp and paper production **(Recommended actions S4 & O4)**
T5. Difficulties in establishing a management system as most companies in the paper recycle industry are small, scattered sellers **(Recommended action S3)**
T6. There is a corporate sustainability target in the global environment trend and a change in environment-label-specific regulations. **(Recommended actions O2 & S2)**

Fig. 2. SWOT Matrix.

Table 5. Internal Factor Analysis Summary (IFAS).

INTERNAL FACTORS (STRENGTHS & WEAKNESSES)				
Strategic Factors		**Weight**	**Rating**	**Score**
Strengths	A growing interest in the paper industry in the implementation of LCA for measuring greenhouse gas emissions	0.11	4	0.44
	An implementation of the life-cycle assessment (LCA) method for evaluating the environmental performance	0.11	4	0.44
	An intention to identify economic prospects and greenhouse emissions in the context of sub-standard recycle vendor integration	0.06	3	0.18
	An intention to present an initial LCA study on paper production waste using the "gate-to-gate" life-cycle	0.06	3	0.18
	An implementation of LCA-AHP as a basis for measuring the paper industry performance	0.06	4	0.24
	A method recommended by the European Commission for an Environmental Footprint Guidelines for paper products	0.05	3	0.15
	LCA calculation within a given time period giving consistent results for the determination of stages in a paper waste life-cycle	0.05	4	0.2
	TOTAL	**0.5**	**25**	**1.83**
Weaknesses	A need of representative, accurate, and high-quality data and of periodic updates in the LCA method	0.17	2	0.34
	A high amount of time needed in the implementation of LCA calculation to one of a line of products	0.06	2	0.12
	Difficulties faced by non-expert organization staff to effectively interpret LCA results	0.06	2	0.12
	Static marginal technologies' incapability to accurately measure LCA results	0.06	1	0.06
	Most of resource waste and greenhouse gas emissions is caused by low life-cycle levels as in China.	0.05	2	0.1
	Although two products are paper products, different factory configurations may entail a significant difference in pulp/paper-making technologies with different life-cycle environment footprints.	0.05	2	0.1
	Low-carbon energy conversion is inapplicable in the short term due to limitations in equipment and funding.	0.05	1	0.05
	TOTAL	**0.5**	**12**	**0.89**

Table 6. External Factor Analysis Summary (EFAS).

EXTERNAL FACTORS (OPPORTUNITIES & THREATS)				
Strategic Factors		**Weight**	**Rating**	**Score**
Opportunities	LCA can minimize negative environments that can cause mental problems during the manufacturing process.	0.15	4	0.6
	Solution to paper recycle problems such as transport, water balance, and energy	0.15	3	0.45
	Proposal of ways of achieving reduced emissions in the paper industry	0.05	4	0.2
	Advantages of evaluating greenhouse gas emissions from a paper-making industry chain	0.05	4	0.2
	Being helpful in identifying previous research trends and providing a benchmark	0.05	3	0.15
	Clear, complete system chain data useful to increase the accuracy of the LCA method	0.05	3	0.15
	TOTAL	**0.5**	**21**	**1.75**
Threats	The paper industry is categorized as an industry heavy in greenhouse gas emissions and ozone depletion.	0.24	2	0.48
	Chronic water ecotoxicity results in a side effect on the water ecosystem from the substances produced.	0.09	1	0.09
	A contradiction between increased development and paper industry waste life-cycle level as in China	0.05	2	0.1
	Failures to achieve the greenhouse gas emissions reduction target as a result of rapidly increasing pulp and paper production	0.04	2	0.08
	Difficulties in establishing a management system as most companies in the paper recycle industry are small, scattered sellers	0.04	1	0.04
	There is a corporate sustainability target in the global environment trend and a change in environment-label-specific regulations.	0.04	1	0.04
	TOTAL	**0.5**	**9**	**0.83**

Rating description:
1 = Very low
2 = Low
3 = High
4 = Very high

Weighting and Matrix Rating
- Internal Analysis Coordinate (x) :
= (Strengths Total Score – Weaknesses Total Score)
= 1.83 – 0.89
= 0.94
- External Analysis Coordinate (y) :
= (Opportunities Total Score – Threats Total Score)
= 1.75 – 0.83
= 0.92

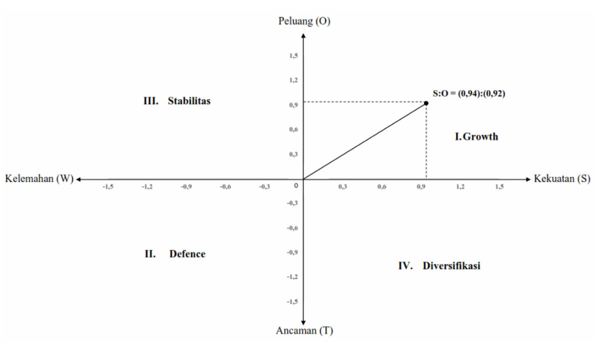

Fig. 3. Cartesian Diagram of the SWOT Analysis.

Based on the figure above, Company X in applying LCA was within Quadrant I, that is, in support of Aggressive Strategy. This shows that not only did it have internal strengths that it could harness to seize the opportunities available, which could increase its sales, Company X also has the ability to implement LCA to compete in the business world. Being in Quadrant I was highly beneficial for the company as there were plenty of opportunities and strengths that the company could take advantage of. The strategy suggested in such a condition is to support aggressive growth policy (growth-oriented strategy).

5 Conclusion

LCA is a structured method that is globally recognized and applied, particularly to assess and evaluate (sustainable) environmental impacts on an ecological basis in the pulp and paper industry. LCA has been significantly developing overseas, especially in China and Europe. In Indonesia, Company X as a company running in the pulp and paper industry has attempted to implement the LCA method to evaluate the environmental impacts rendered by its manufacturing process. Therefore, a SWOT analysis was conducted to identify the strengths, weaknesses, opportunities, and threats faced by Company X in implementing LCA.

The findings highlighted that most of the pulp and paper industry enjoys numerous internal strengths and external opportunities and faces various internal weaknesses and external threats. Currently, Company X occupied the first quadrant (growth), indicating that the company was in a highly profitable position. The company had a lot of strengths and opportunities. It is, thus, important for the company to take advantage of its strengths to capture opportunities to minimize its emissions into the environment and to apply LCA. This research has a limitation in the data used, which were secondary data from a desk study with relatively low accuracy value. Therefore, it is necessary to conduct a further study to process data using primary data in order to obtain more accurate results.

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