

Socio-economic Life Cycle Assessment of Silangit Airport in Lake Toba Area

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Abstract: The objective of this study is to identify social implications of Silangit Airport of Lake Toba Area using Social Life Cycle Assessment methodological framework. The assessment involves relevant stakeholders, such as employees, local community members, government, and consumers. The assessment criteria are adopted from Society of Environmental Toxicology and Chemistry/United Society of Environmental Programme Code of Practice. Each criterion was weighted by employing an expert survey. Stakeholders' perspectives were gauged by measuring gaps between expectation and perception, which are gauged using seven-point Likert Scale. Scoring process was conducted by multiplying the weighting and gauging to get result interpretation. Twenty-three social criteria were developed into five social impact categories; human rights, working condition, cultural heritage, social-economic repercussion, and governance. The results of the stakeholders' survey in each category reveal that stakeholders' expectation on socio-economic criteria is generally met by the actual practice of Silangit Airport. However, small negative gaps are seen in the criteria safe and healthy living condition, transparency on social/environmental issues and horizontal conflicts are at minimum.

Keywords: social life cycle assessment, sustainability, stakeholders, airport

Introduction

The concept of corporate sustainability has gained importance in recent years in both organizational theory and practice¹. Social Life Cycle Assessment (SLCA) is assessment of socio-economic impacts of the system in its life cycle to identify the directly or indirectly affected stakeholders²⁻⁴. Social aspect of sustainability supports the concept of intragenerational justice, which means that future generations are entitled with the same of greater quality of life as current generations⁵. Most SLCA frameworks/methods are goal-oriented, some have predetermined objectives (e.g., identification of hot spots, comparative and/ or non-comparative goals)⁶. SLCA is best used to increase knowledge, inform choices, and promote improvement of social conditions in the product life cycle⁷. This means that social life cycle assessment is important to be applied.

Based on the literature review, it can be found that there were many researchers applied this method to assess the sustainability for social impacts. A research used social life cycle assessment to identify the social implications of palm oil biodiesel and found that the critical social hotspots were working conditions and cultural heritage⁸. A research also conducted an initial assessment related to the social life cycle impacts related to biodiesel production and consumption in South Africa⁹. It shows that social problems that occur in South Africa include low wages for agricultural workers, the use of illegal workers from neighboring countries, crimes against commercial farmers and child labor. The hotspots identified were the social conditions of agricultural workers, exploitation of immigrants, and the economic needs of empowering groups who were previously disadvantaged in the process of developing biodiesel. Another research also analyzed the social impact of accommodation facilities on tourism to promote improvement social conditions, and the overall socio-economic performance of a product throughout its life cycle on behalf of the stakeholders¹⁰. The research shows that the negative impact is cultural heritage and the positive impact is income. So, this research emphasizes the importance relationships that must exist between tourist accommodation services and the local community as a whole, with specific reference to local administrative structures and company networks.

All research mentioned above adopted Society of Environmental Toxicology and Chemistry/United Society of Environmental Programme Code of Practice as guidelines to assess the social impact by implementing the categories and each criterion. The guideline examines categories in terms of social aspects systematically because they are accompanied by each related criterion. The guideline also classifies stakeholders according to the criteria so that the researcher can be structured to identify each criterion in accordance with the case study being investigated. This is what underlies the authors determine UNEP-SETAC as a guide in conducting social life cycle assessments. The author identifies hotspots and not hotspots as the output of this study by examining the criteria with UNEP-SETAC guidelines whose criteria are categorized based on human rights, working conditions, cultural heritage, economic and governance impacts¹¹.

The goal of this study is to assess the social implication of airport. The specific questions will be answered to get the goals for this research:

- What are the social criteria used to assess the social implication of Silangit Airport?
- What is experienced and expected by Silangit Airport's stakeholders in terms of airport operational activities from a social perspective?
- What are the social sustainability hotspots in Silangit Airport that needs further research and policy?

The case study was conducted in Silangit Airport, Lake Toba Area, North Sumatera, Indonesia in January to June 2020. The object was chosen because of its significant role as infrastructure that facilitates the accessibility of Lake Toba Area as one of National Strategic Tourism Area¹². The scope of this study is operational activities of airport. Overall, the

steps used are same but the difference is in the method for weighting. In this research, the method used for weighting is pairwise comparison method. The goal is to get the ranking with the consideration of expert consistency in evaluating the survey. The assessment results were then analyzed to get the insight and interpretation.

Research Method

Sustainability has become a core issue on the political agenda, and this interest also resonates at the scientific level because many approaches and methods are proposed and developed¹³. SLCA's are tools to aid decision-making; however, they require a methodology able to capture contextual issues^{14,15}. The methodology used in this study consists of several steps. The steps are defining the goal and scope, developing and weighting each criterion, gauging the stakeholders' perspective, assessing the operational system of airport based on the criteria, and scoring the assessed system. The goal and scope have been explained in previous section.

Developing and weighting criteria

The social impacts criteria in this study were developed by adopting Society of Environmental Toxicology and Chemistry (SETAC)/United Nations Environment Program (UNEP) Code of Practice. The experts were participated to involve in the survey as decision makers in weighting the importance of each social impacts criteria. Experts were selected based on their insight and experience about airport.

In multicriteria decision analysis, it is important to apply a weighting system for each criteria based on experts' evaluation. The method used to rank the criteria was pairwise comparison. The experts assigned direct ranking on each criteria by using a questionnaire. Ten experts were participated in this weighting process. They were local government (such as senior officials), academic, Non-Government Organization (NGOs) and community leaders. In collecting the data, some experts filled the paper questionnaire while others filled out the electronic version of questionnaire online. By using the pairwise comparison method, the participants were asked to compare each category and criteria from 1 to 9, where 1 means both elements are equally important; 3 means one element is slightly more important than the other; 5 means one element is very essential or very important than other elements; 7 means one element is clearly more important than the other elements; 9 means one absolute element is more important than the other elements and 2,4,6,8 means the values between the two considerations are close together. The result of the criteria development and weighting is 23 weighted social criteria classified into 5 social impacts categories. They are human rights, working conditions, cultural heritage, socio-economic repercussion, and governance.

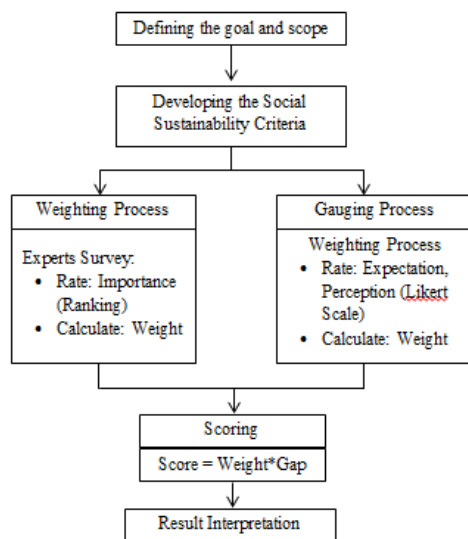


Figure 1. Framework of Research Methodology

Table 1. Impact Categories, Criteria, and their Weights

Impact Categories	Weight	Criteria	Label	Weight
Human right	0.409	Free from the employment of child labor	A1	0.146
		Free from the employment of forced labor	A2	0.070
		Equal opportunities, free from discrimination	A3	0.193
Working condition	0.125	Freedom of association and collective bargaining	B1	0.008

		Fair salary	B2	0.012
		Descent working hours	B3	0.025
		Occupational health and safety	B4	0.035
		Social benefit	B5	0.046
Cultural heritage	0.127	Land acquisition, delocalization, migration	C1	0.008
		Respect on cultural heritage and local wisdom	C2	0.009
		Respect on customary right of indigenous people	C3	0.009
		Community engagement	C4	0.022
		Safe and healthy living condition	C5	0.025
		Access to material resources	C6	0.016
		Access to non-material resources	C7	0.008
		Transparency on social/environmental issues	C8	0.029
Socio-economic repercussion	0.203	Contribution to local employment	D1	0.041
		Contribution to economic development	D2	0.033
		Food security	D3	0.038
		Horizontal conflict	D4	0.031
		Transfer of technology and knowledge	D5	0.059
Governance	0.137	Public commitments to sustainability	E1	0.019
		Free from corruption	E2	0.118
Total	1			1

Gauging the stakeholders’ perspective

In S-LCA, it has been noted that for supporting management decisions it should be sufficient to include only those parts of the life cycle which can be directly influenced by the company¹⁴. The stakeholders involved for gauging the stakeholders’ perspective are: (1) Workers: these are employees in airport supply chain, such as: airport worker, airport manager and third party. (2) Local community: these are people who live in Silangit area; they are considered as directly affected community. (3) Consumer: these are people who use airport services for tourism or not. (4) Government: these are people who act in all aspects of governance of the airport. In order to avoid the biased point of view, participants who have two or more roles as stakeholders were excluded.

One hundred and sixty-seven subjects participated in the survey by filling the questionnaire in papers and electronic version of questionnaire online. Each type of stakeholders was represented at least 30 participants randomly.

Table 2. The Criteria Assessed by Stakeholders

Criteria	Stakeholders			
	Workers	Local Community	Government	Consumer
A1-A3	✓			✓
B1, B2, B5	✓			
B3, B4	✓			✓
C1-C8		✓		
D1-D5		✓	✓	
E1, E2			✓	

Stakeholders were asked to fill out a questionnaire in order to identify the perspectives and expectations experienced by each criterion in the category. In each criterion, perspective and expectations are measured using a 7-point Likert scale. In the gauging of stakeholder perspectives, 1 means very hopeless and 7 means very hopeful. In the gauging of stakeholder expectations, 1 means very incompatible and 7 means very appropriate.

Table 3. Result from Stakeholders Survey

Impact	Human Right			Working Conditions				
	A1	A2	A3	B1	B2	B3	B4	B5
Expectation	6.625	0.000	6.779	6.133	5.655	5.845	5.856	5.448
Perception	6.837	0.000	6.894	7.000	6.828	6.534	6.635	6.967
Gap-mean	0.212	0.000	0.115	0.867	1.172	0.689	0.779	1.518
Gap-SD	0.090	0.000	0.092	0.080	0.071	0.077	0.077	0.067

Impact	Cultural Heritage							
Criteria	C1	C2	C3	C4	C5	C6	C7	C8
Expectation	5.727	6.091	6.000	6.091	6.636	5.697	5.667	6.242
Perception	6.030	6.303	6.121	6.091	5.697	5.758	5.697	5.061
Gap-mean	0.303	0.212	0.121	0.000	-0.939	0.061	0.030	-1.182
Gap-SD	0.247	0.265	0.263	0.269	0.315	0.250	0.250	0.303

Impact	Socio-econ. repercussion					Governance	
Criteria	D1	D2	D3	D4	D5	E1	E2
Expectation	6.410	6.475	6.000	6.443	6.000	6.500	6.500
Perception	6.541	6.541	6.377	5.475	6.410	6.786	6.786
Gap-mean	0.131	0.066	0.377	-0.967	0.410	0.286	0.286
Gap-SD	0.150	0.152	0.137	0.164	0.137	0.310	0.310

Based on the results obtained from the gauging of stakeholders’ perspective and expectations, it can be measured the gap of each criterion in the category of airport. If the gaps are zero so the actual condition of social aspects exactly matches the stakeholders’ expectation; if the gap is positive so the actual condition of social aspects exceeds matches the stakeholders’ expectation and if the gap is negative so the actual condition of social aspects are not in accordance with the stakeholders’ expectation. After identifying the gaps, the scoring value can be got by multiplying the gap and weight of each criteria and summing up to get a final score.

Results and Discussion

Average gaps of each category as stakeholders’ perspective are shown in a radar chart (Fig. 2). The red line in the chart reflects the actual condition that meets the expectations (i.e., gap=0) while the blue line in the chart reflects the stakeholder’s perception during this research.

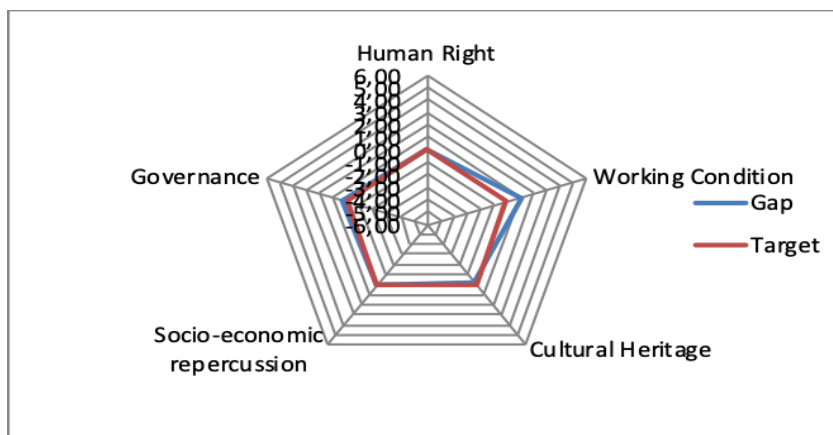


Figure 2. Stakeholders’ Perspective in a Radar Chart

Based on Figure 2, it shows that all categories were in target, tolerance limit and maximum conditions. It was also supported by the overall score of the assessed system, which is the sum product of the multiplying result of gap and weight of each criterion, is 0.821. This result means that stakeholders’ overall perception on the social impacts of the assessed product system is bigger than their expectation. The detail analysis of the result will be discussed in the following subsection.

Human Rights

The average gap of human rights is 0.110 that means the perceived conditions slightly exceed expectation. This is because in airport operational activities, workers must be older than 18 years old. It is supported by the regulations set by PT Angkasa Pura II as the airport manager that during the administrative process of job recruitment, applicants must be older than 18 years old. In addition, based on observations by researchers in some of the smallest to largest work units, no child labor was found under the age of 15 years old.

On the other hand, based on interviews conducted to the airport during this field research, all performance held by workers in accordance with the agreed job desk before entering a concentration of fields without any coercion. Airport also gives equal opportunity and free from discrimination. For the example is the general recruitment of workers.

Working Conditions

The average gap of 1.010 in the working conditions confirms that the perceived conditions slightly exceed expectation. The airport stated that in the operational activities of the airport freedom of association and collective bargaining is realized through the provision of meetings regularly or irregularly. The workers confirmed that routine meetings must be held every week where the members of the meeting are all related leaders consisting of all managers and assistant managers. For other workers, meetings are also held irregularly where workers can hold meetings if there are matters that need to be discussed together in order to carry out deliberations to reach consensus.

In addition, workers also received a minimum wage of IDR 2,542,836 per month in accordance with the provisions of the North Tapanuli Regency minimum wage. The determination of a reasonable salary is for all elements directly related by the airport. For descent working hours criteria, operational working hours applied consist of two, namely for workers in the office is 08.00-17.00 WIB and field operational workers are 07.00-16.00 WIB. For workers having a break at 12.00-13.00 WIB and on Friday starting at 12.00-14.00 WIB to appreciate the workers who perform worship. Workers are required to work from Monday to Friday but workers who work directly at the airport continue to work for Saturday and Sunday on a shift system so that each worker gets a decent working hour in accordance with Indonesian regulations.

Occupational health and safety are also addressed with supporting safety facilities in accordance with workers' job desks and the division concerning in risk and quality control. For social benefit criteria, the airport provide the social security called *BPJS Ketenagakerjaan*.

Cultural Heritage

The average gap of cultural heritage is -0.174. Although the value is slightly negative, it still reaches the tolerance limit because there is no significant difference between expected and perceived condition. Nevertheless, the airport still needs to pay attention to each criterion so as not to create a greater negative gap. The criteria that influence this value will be discussed in detail. For land acquisition, delocalization and migration of the airport.

This is because based on interviews conducted during the research to local communities, especially people in the Pariksubungan Village area, Silangit that the process of land conversion did not go through coercion but through stages. *Lembaga Aspirasi Masyarakat Indonesia* (LAMI), the Forum Bangso Batak Indonesia (FBBI) North Tapanuli regency as NGOs in North Tapanuli confirmed that the process carried out was a socialization to the community and then compensation from the airport to the land owners consisting of several people.

For respecting on cultural heritage and local wisdom criteria, airport paid attention by implementing culture in operational activities. The example is like the inauguration of the airport by the president of the Republic of Indonesia, Mr. Joko Widodo by using the Batak culture as the majority tribe in the Lake Toba area. The airport does not violate the community's customary rights as it does with land ownership rights. Based on interviews conducted with local communities, especially Pariksubung villages, the process of land conversion that was not forced was given compensation to the community. In Batak terms, the method applied is called as a *pago-pago*, which means a ceremony carried out to formalize the handover of a piece of land to another party. In its operational activities, the airport also involves the community in a participatory manner. Based on the experience of the surrounding community, it is confirmed that local people are often involved in various airport events such as Christmas religious events, participants in the appearance of Batak tribal traditional dances known as *tor-tor* and other examples.

Based on interviews conducted with LAMI, FBBI and a number of other local communities, this was affected by increasing pollution after the presence of Silangit Airport where the area was previously a pristine rural area with minimal aircraft activity. Air pollution is caused not only by land transportation activities which are increasing but also due to air transportation activities as a function of airports that emit gases such as carbon dioxide which can interfere with health and environmental conditions.

The International Civil Aviation Organization (ICAO) is an international civil aviation organization as a special UN agency to manage the administration and governance of the International Civil Aviation Convention. Based on the estimation of carbon dioxide (CO₂) estimation with a case study of the Silangit International Airport using the International Civil Aviation Organization (ICAO) Carbon Emissions Calculator, it was found that the CO₂ gas content produced annually by the activities of the Silangit airport always increased.

Table 3. Estimation of CO₂ Caused by Aircraft Activities

Purpose		Average passanger						Distance (km)	Aircraft Fuel Burn/journey (kg)	Total Passengers' CO ₂ /Journey (kg)					
		2014	2015	2016	2017	2018	2019			2014	2015	2016	2017	2018	2019
Domestic Travel	DTB - BTH	6001	4421	38284	70223	104745	87321	583	3693.2	395222.5	291164.6	2521363	4624848	6898447.9	5750912.8
	DTB - CGK	6001	4421	38284	70223	104745	87321	1260	5779.7	747009.1	550329	4765621.7	8741413	13038738.1	10869785.2
	DTB - HLP	6001	4421	38284	70223	104745	87321	1289	6212	664760	489735.8	4240906.1	7778945.6	11603116.6	9672974.8
	DTB - KNO	6001	4421	38284	70223	104745	87321	153	379.6	99357.1	73197.4	633858.9	1162665.1	1734237.4	1445752.5
Internasional Travel	DTB-KUL	-	-	-	1347	6878	27300	306	2434.8	-	-	-	58485.2	298634.8	1185334.3
TOTAL										1906349	1404427	12161750	22366357	33573174.8	28924759.6

The increase of CO₂ gas will certainly have a negative impact not only on the condition of the community but also on the environment and the earth. Although natural processes are able to reduce CO₂ in the atmosphere, human activity releases CO₂ into the air much faster than nature's ability to reduce it that can impact on global warming¹⁶. This is known as a symptom of the greenhouse effect. In addition, the increased activity of the Silangit airport can also threaten the security of the community. This is also because since 2017, passengers are not only on a national scale but also internationally. Based on interviews conducted with local people, the community was worried because of airport activities that are still active because it creates insecurity for the community. This insecurity was driven by the development of Corona Virus Disease-19 (COVID-19) which posed a threat to each country. Based on interviews conducted at the airport, flight activity is still active but is limited in the span of April to May according to the latest information. This has added to the concern of many parties, especially the local community.

In addition, the existence of the airport still provides access to material resources such as plantations and non-material such as graves and ancestral lands. But for transparency of social and environmental issues, it also still needs attention because has reached the minimum point. This is due to the lack of publicity related to social and environmental issues due to airport activities. This was also confirmed by the airport that the lack of detailed procedures related to the flow of activities in the publication of social and environmental issues.

Socio-economic repercussions

The average gap of 0.003 in the working conditions confirms that the perceived conditions slightly exceed expectation. The criteria that influence it are contributions to local workers, contributions to the economic development of society, contributions to the improvement of food security, horizontal conflicts and contributions to the transfer of technology and knowledge.

With the presence of Silangit International Airport, of course, it will open up employment opportunities for anyone including the local community. In an interview with the local community, the airport provided the opportunity for the community to follow the job application process. This was also confirmed by several workers during the fieldwork where many workers came from the North Tapanuli and Toba Samosir areas.

On the other hand, in an interview, there were people who previously did not have a business but when the existence of the airport opened a business to increase revenue. Economic development has also increased due to the velocity of money in the airport and surrounding areas. The presence of the Silangit airport also creates employment opportunities, thereby contributing to reducing unemployment.

In helping economic development, the Silangit airport also conducts Corporate Social Responsibility (CSR) to the local community, such as giving an ambulance to the Silangit Puskesmas. This certainly helps the community health center in minimizing funds for the provision of ambulances. To help with transportation activities, the airport also provides CSR for paving roads in the area of the Sipintu-Pintu HKBP church complex, Silangit. This shows that the airport contributed to the economic development of the community.

Along with the positive contribution to community economic development, it also affects the improvement of food security. This is because the availability of food and the ability to be able to access it can still run smoothly so it does not pose a threat of hunger to the community. Developing economic factors also trigger an increase in food security.

But the criteria for horizontal conflict have reached the minimum point. Horizontal conflict generally occurs due to lack of socialization to the community related to several important issues. In addition, the airport stated that a detailed and systematic flow procedure not established yet to deal with problems that caused horizontal conflicts. Through regional mass media in 2018, it was stated that there was a conflict between the local community, especially the people of Pariksubung Village, Silangit and the airport. It is because the airport's change of name from Bandar Udara Internasional Silangit to Bandara Sisingamangara XII¹⁷. In the news circulating and reported by several local people in an interview that there was no accurate reason why the name of the airport was changed. Without socialization with the local community, Ministry of Transportation's Decree No. 1404 in 2018 was issued concerning the change of name of *Bandar Udara Internasional Silangit* through the approval of President Joko Widodo. This triggered a demonstration by the local community of Pariksubung Village. This name change has a negative impact where there is no consistent use of the name. In interviews during the research with the airport, it was confirmed that the two airport names were still used in operational activities, namely *Bandara Sisingamangaraja XII* and *Silangit International Airport*

In addition to conflicts related to name change, conflicts related to land use change also still occur. Through direct observation of researchers that there is a plaque containing the name of community land ownership located next to door 2 when entering the airport. Based on in-depth interviews with community leaders in Pariksabung Village, the landowner claimed that he had not received compensation for the conversion of land while the airport claimed that the land had been compensated.

The airport also contributes to the transfer of technology and knowledge such as the digitalization system adopted by the airport so that the public also adapts, for example online ticket reservations.

Governance

Based on the results obtained indicate that the category of government has a gap of 0.286 which indicates that the actual conditions slightly exceed the expectations of stakeholders. The criteria that influence it are gaining public support for sustainability and corruption free. Gaining public support for sustainability criteria is implemented. The reason is such as road construction, assisting in the provision of supporting facilities such as public ground transportation which facilitates access to airports and funding for governance.

Department of Transportation stated that the airport is also free of corruption. This is because all performance is carried out in accordance with agreed standard operational procedures (SOP). Digital technology support also produces administrative processes that are more detailed and transparent when accessed compared to manuals.

Conclusion

It can be concluded that overall, there is no significant socio-economic hotspots found in the operational practice of Silangit Airport as the assessment indicate very small gaps between stakeholders' perception and expectation in all criteria.

To ensure the sustainability of airport's operational activities so each category should still be on these neutral and maximum limits are maintained and increasingly developed, especially the category of cultural heritage which has small negative gaps that can potentially reach the minimum threshold.

The things that can be recommended especially to increase the negative criteria are to provide CSR regularly to the community to get more public support, to promote nature conservation such as planting trees as a contribution in implementing healthy conditions for the ecosystem, applying strict health protocol regulations in anticipating COVID-19 due to airport activities so as not to increase the impact of exposure to the disease, implementing policies to inform the public regarding prevention, anticipation and concrete activities that have been prepared and carried out to prevent the spread of COVID-19 in order to minimize public concern through various media. The mass media is also increasingly active in informing the public about prevention, anticipation and concrete activities that have been prepared and carried out to prevent the spread of COVID-19 in order to minimize public concern through various media. Overall, these stakeholders must provide accurate and factual information.

To further streamline the performance flow in dealing with horizontal conflicts and apply transparency to social and environmental issues, the airport is also advised to make a clear flow chart that contains detailed steps related to the ways taken to produce a directed solution.

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References

- [1] M. K. Linnenluecke and A. Griffiths, "Corporate sustainability and organizational culture", *J. of World Business.*, vol.45, no.4, (2010), pp. 357-366
- [2] Y. Manik and A. Halog, "Life Cycle Sustainability Assessments", *Encyclopedia of Inorganic and Bioinorganic Chemistry*, (2016), pp. 25-40
- [3] C. Reiting, M. Dumke, M. Barosevcic and R. Hillerbrand, "A conceptual framework for impacts assessment within SLCA", *Int. J. Life Cycle Assess.*, vol. 16, (2011), pp. 380-388.
- [4] M. Finkbeiner, E.M. Schau, A. Lehmann and M. Traverso, "Towards Life Cycle Sustainability Assessment", *Sustainability*, vol. 2, (2010), pp. 3309-3322.
- [5] G. Goniadis, "Introduction to Sustainable Development: A brief handbook for students by students", International Hellenic University Publisher, (2015).
- [6] R. Wu, D. Yang and J. Chen, "Social Life Cycle Assessment Revisited", *Sustainability*, vol.6, (2014), pp. 4200-4226
- [7] C. Benoit, GA Norris, S. Vladivia, A. Ciroth, A. Moberg, U. Bos, S. Prakash, C. Ugaya, T. Beck, "The guidelines for social life cycle assessment of products : just in time!" , *Int. J. Life Cycle Assess.*, vol. 15, (2010), pp. 156-163.

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- [8] Y. Manik, J. Leahy and A. Halog, "Social Life Cycle Assessment of Palm Oil Biodiesel: A Case Study in Jambi Province of Indonesia", *Int. J. Life Cycle Assess.*, vol.18, (2013), pp. 1386-1392.
- [9] C. Mbohwa and N. Myaka, "Social Life Cycle Assessment of Biodiesel in South Africa", *EcoBalance*, (2010).
- [10] G. Arcese, M. C. Lucchetti and R. Merli, "Social Life Cycle Assessment as Management Tool: Methodology for Application in Tourism", *Sustainability.*, vol. 5, (2013), pp. 3275-3287.
- [11] UNEP-SETAC, "Guidelines for Social Life Cycle Assessment of Products", United Nations Environment Programme-Society of Environmental Toxicology and Chemistry, (2009).
- [12] N. Paramitha, Y. Manik and H. Anthony, "Identification, Characterization and Stakeholder Analysis of Eco-tourism Destination in Lake Toba Area", *International Journal of Tourism & Hospitality in Asia Pasific.*, vol. 2, no.1, (2019), pp.1-8.
- [13] A. Zamagni, "Life Cycle Sustainability Assessment", *Int J Life Cycle Assess.*, vol. 17, (2012), pp. 373-376.
- [14] S. Mathe, "Integrating Participatory Approaches Into Social Life Cycle Assessment: The SLCA Participatory Approach", *Int J Life Cycle Assess.*, vol. 19, (2014), pp. 1506-1514.
- [15] S. A. Hosseinjou, S. Mansour and M.A. Shirazi, "Social life cycle assessment for material selection: a case study of building material", *Int J Life Cycle Assess.*, vol.19, (2014), pp. 620-645.
- [16] D. Pujiastuti, E. Melayeta, B. Mustafa, "Analisis Efek Karbon Dioksida (CO₂) terhadap Kenaikan Temperatur di Bukit Kotabangun Tahun 2005-2009", *Jurnal Ilmu Fisika (JIF).*, vol. 2, no. 2, (2010), pp. 56-67.
- [17] Indonesia, Keputusan Menteri Perhubungan Republik Indonesia tentang Penetapan Bandar Udara Silangit di Kabupaten Tapanuli Utara, Provinsi Sumatera Utara menjadi Bandar Udara Internasional Silangit, KP 821 tahun 2017, (2017).