Social Impact of Small Seawater Desalination Plant of Local Community: A Social Life Cycle Assessment

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Abstract

Apart from Malaysia being supplied with and having abundance of water resources, the country is also experiencing increasing problems concerning water resources. Kampong Pantai Senok, Bachok is one of the affected areas in Kelantan that are having issues with immoderate amounts of water consumption, unsatisfactory services by the water company due to rapid social and economic growth. Therefore, a small seawater desalination plant is installed to address these issues. The objective of this study is to identify the potential social impact associated with stakeholder participation, which is the local community, using Social Life Cycle Assessment (S-LCA) as a methodology. In S-LCA, the methodology very much resembles the Life Cycle Assessment (LCA) framework and both assessments gave phases of procedures, which are goal and scope definitions, the Life Cycle Inventory (LCI), the Life Cycle Impact Assessment (LCIA) and interpretation. A set of questionnaires was developed using the selected sub-categories proposed by UNEP (2009) to be accessed by the stakeholders (local community). The results showed positive social impacts for the local community, as satisfaction is high for the sub-categories involved.

Keywords
Social impact, Local community, Social Life Cycle Assessment (S-LCA), Desalination plant

1. Introduction
The importance of water in life is very significant and cannot be denied as water is the most valuable natural resource compared to others. According to the World Health Organization, one in three people on the global continent are affected by these water scarcities and almost one fifth of the world inhabitants live in areas with water shortage problems. Although Malaysia is provided with plentiful of water resources, the country is also experiencing increased demand of water for the past few years. Additional reasons for the water resource problems in this country are due to growth population, urbanization and improving of life standards. It also unveiled the lack of access to fresh and clean water supply at rural populations compared to urban people (Ahmed *et al*., 2014). As in Kelantan, due to the increasing

population and land use changes, the Kelantan River basin had less water supply than the public demand and this issue is expected to worsen in the future (Fitri *et. al*., 2020).

According to the report from National Water Resources Survey, the abstraction rate for drinking water from Kelantan River was 60% or 254.074 million litres per day while from groundwater was 40% or 176.342 million litres per day. The outdated fashion of water conveyance and insufficient storage capacity limited the conventional water distribution to the consumers (Kamaludin *et al*., 2013). This seawater desalination plant is the first plant installed in Malaysia by the government to provide safe drinking water in the area with water scarcity and low quality of groundwater. Although the installation of the seawater desalination plant contributed significantly to the local community, the social aspects are also important and often neglected. Therefore, this study was conducted in order to identify the social impact from the overall process of seawater desalination plant using the Social Life Cycle Assessment (SLCA). The social indicator from the installation of the plant that involves the description analysis by accessing the social impacts associated with the stakeholder including local communities were evaluated using the SLCA. According to UNEP (2009), SLCA is a methodology to access the social potential and both the positive and negative socio-economic impacts of the products/services through its life cycle.

1.1 Objectives

The goal of this study is to identify the local community hotspot of potential social impacts from the installation of a seawater desalination plant in Kampung Pantai Senok, Bachok, Malaysia.

2. Area of study

This study was conducted in Kampung Pantai Senok, Bachok with a population of nearly 3000 people. The selection of this area as a study site was purposive as the seawater desalination plant was built in Kampung Pantai Senok, Bachok in 2018. Kampung Pantai Senok is in Mukim Senok, Bachok District, Kelantan (Figure 1) with coordinates of 6.16°N, 102.32°E and located along the coastal area of Pengkalan Datu River. It is located about 20 km from Kota Bharu, Kelantan via the local road from Kota Bharu-Tawang-Bachok which takes about 30 minutes (Pejabat Tanah Jajahan Bachok, 2018). According to the Bachok District and Land Office, there are several small industries that contribute to local community income, such as dried fish manufacturing and local tourist attractions in the Bachok District. But generally, in Kampung Pantai Senok, the socio-occupational sectors for the villagers are such as fishermen, farmers and engaging with tourism since the village is located on a beach called Malaysia's Nami Island. The seawater desalination plant is located at Lot 1968 and 78 at Kampung Pantai Senok with a total area of 762 square meters.

Figure 1: Maps of Bachok District, Kelantan (Source: JPS Bachok, 2018)

3. Materials and Methods

Social Life Cycle Assessment (S-LCA) is a social and potential impact assessment that seeks to assess the social and socio-economic aspects of products or services throughout their lifecycle (Amir Hamzah et al., 2019). The S-LCA extends from Life Cycle Assessment (LCA) to guidelines of ISO 14040 and ISO 14044. **Figure 2** shows the S-LCA framework according to the S-LCA concept, based on the UNEP 'Guidelines for Social Life Cycle Assessment of Products' (2009) that is divided into four phases: goal and scope definition, social life cycle inventory, social life cycle impact assessment and interpretation of the results.

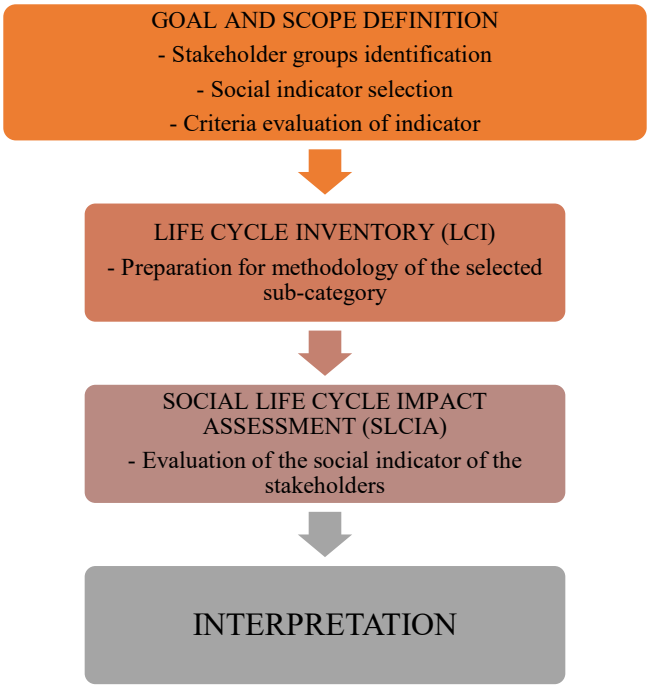

Figure 2: The S-LCA Framework

The scope of the study is a gate-to-gate system boundary which covers only the seawater desalination process (**Figure 3**).

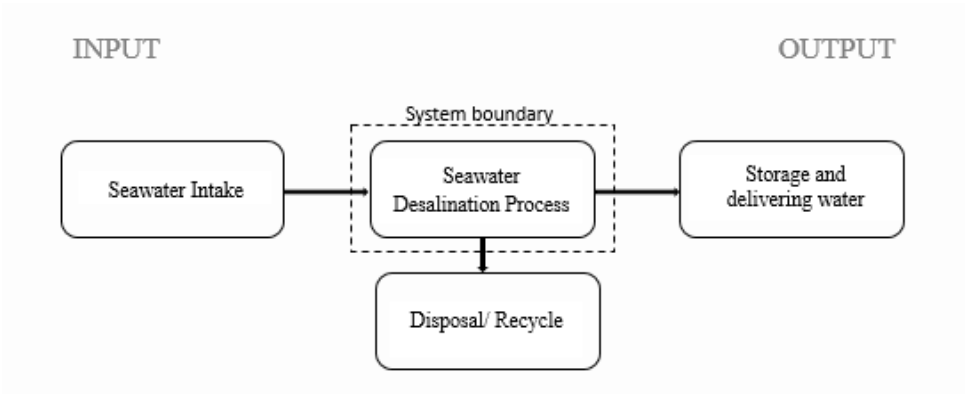

Figure 3: System boundary

3.1 Social Life Cycle Inventory (S-LCI)

In order to assess the potential social impacts in the system boundary of this study, a survey is given to the stakeholders involved, which is the local community. **Table 1** included the stakeholder category and three sub-categories for social impact on local community. One set of questionnaires were constructed and used as the survey instrument to identify

the related data information from local communities based on relevant sub-categories presented in the book by UNEP (2009) "Guidelines for Social Life Cycle Assessment of Products".

The questionnaire of the local community consists of 36 items which were obtained based on a validity and reliability test before the distribution. The Likert's scale with 'strongly agree' (1 point), 'disagree' (2 point), 'neutral (3 point), 'agree' (4 point) and 'strongly agree' (5 point) were used. The questionnaire was set up in two languages (Malay and English) to help the respondents easily understand the listed questions and effortlessly answer them. The population in this study area were 98% Malay, followed by Chinese or not a citizen of Malaysia (Abdul Ghani *et. al.,* 2021).

The sample of the study should be carefully selected as it represents the total population of the study area because it is impossible to include the whole entire population. The population of the local community at Kampung Pantai Senok, Bachok is made up of about 3000 people. A total of 379 respondents were chosen according to Krejcie and Morgan (1970) to represent the total population. Thus, a total of 379 designed questionnaires were distributed equally to the local community around Kampung Pantai Senok.

Table 1: Stakeholder category and sub-categories for social impact assessment

Stakeholder category	Sub-category
Local community	1.Safe and healthy living conditions 2.Community engagement 3.Local employment

3.2 Social Life Cycle Impact Assessment (S-LCIA)

The total social impact on the local community of this study were calculated by the midpoint results calculated from the questionnaire sections as stated in **Table 2**. As stated by Sharaai *et al*. (2019), the midpoint result calculations were obtained from the following equations. Each section of the local community percentage was calculated from the division of each section by total points of all involved sub-categories from the questionnaire. According to research from Dunmade *et al.* (2015), the value of social satisfaction and performance were identified using the interpretation criteria table, as shown in Table 3.

$$n = \frac{x}{x^1} \times 100 \quad (1)$$

Where:
n = Sub-category impact
x = Total of respondents responded
x^1 = Grand total of respondent point

Table 2: The description of the questionnaire sections

Sections	(A) Demographic	(B) Safe and Healthy Living Conditions	(C) Community involvement	(D) Local employment
No. of items	12	10	7	7
Descriptions	General questions regarding respondent backgrounds and profiles	Identification of respondents' viewpoint on their safety and health after the installation of the seawater desalination plant	Identification of respondents' viewpoint on involvement of community	Identification of respondents' viewpoint on the local employment

Table 3: The interpretation of criteria

Percentage score (%)	Description
≥80	Excellent
61-79	Very good
50-60	Good
21-49	Poor
0-20	Very poor

4. Result and Discussion

The last phase of Social Life Cycle Assessment (S-LCA) is interpretation. The interpretation was made after all the data collected from the questionnaire survey were analysed and results from the data were used as the expected outcomes of the study.

4.1 Safe and healthy living conditions

From the results shown in **Figure 4**, the local community believes the installation of the seawater desalination plant near their residential areas do not affect their safety, health and living quality. The local community is not worried of suffering any diseases that may occur from the process. They also feel safe living near the plant as the desalination process does not cause any harm to them or increase the number of criminal activities as police frequently patrol the area. The local community also agreed that the authorities involved provided enough information regarding the seawater desalination along with Standard Operating Procedure (SOP) guidelines. There were no complaints from the local community concerning any activities from the seawater desalination process that may have adverse safety and health effects.

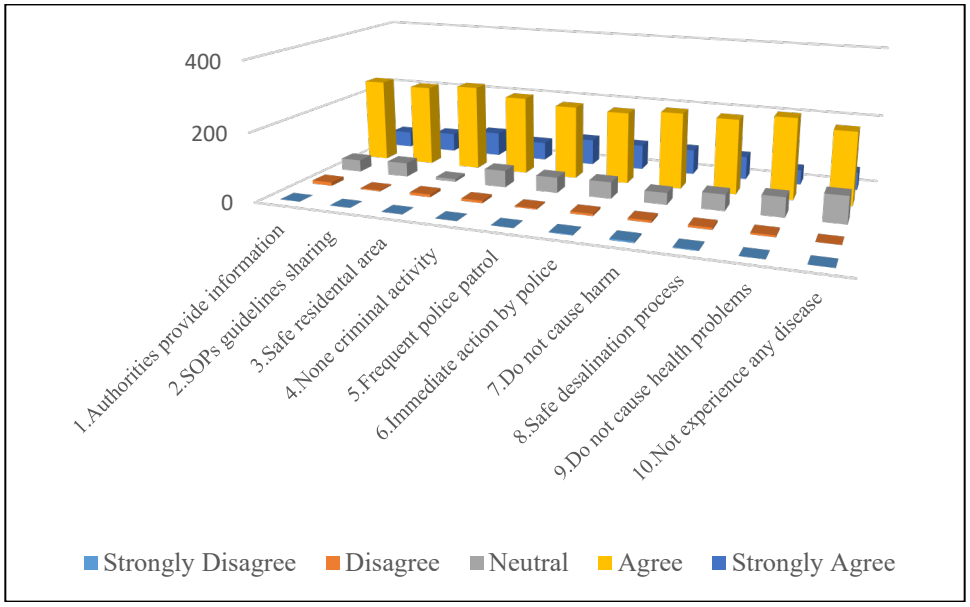

Figure 4: Sub-category results on safe and healthy living conditions

4.2 Community engagement

According to the calculated results in Figure 5, the local community considers that there is involvement of the local community and the management of the seawater desalination plant. The authorities and plant management included the local community in their activities such as *gotong-royong* activities that were held to clean up the area near the plant, constantly sharing useful information regarding desalination plants and also provided information on the person in charge of the plant for them to ask any questions or issues on seawater desalination plant. The potable drinking water provided for the local community were provided continuously and for free with no payment needed to take the drinking water as this seawater desalination is installed for their use since the residents at Kampung Pantai Senok has been facing a shortage of clean water for 45 years.

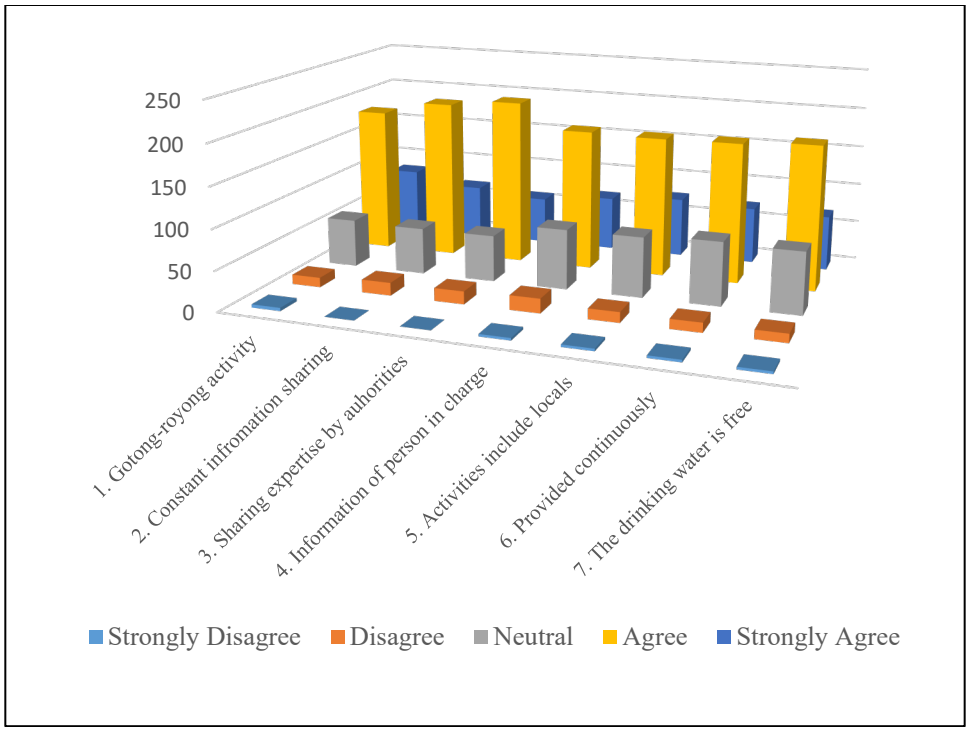

Figure 5: Sub-category results on local community involvement

4.3 Local employment

Based on **Figure 6**, no job opportunities were provided for the local community at Kampung Pantai Senok. Most of the local community disagreed with 1-point and 2-point responses on the questions about job opportunities for the locals. This happened because the seawater desalination plant is still in the early phase, so they provided experienced workers to manage the membrane and chemical usage during the process of seawater desalination. However, the results show that the local community agreed that there are increasing number of visits to Kampung Pantai Senok with the installation of the seawater desalination plant. The residents near this study area were interested in the plant; thus, by the increase of visits, it may also help local community to promote local tourism and new local industries.

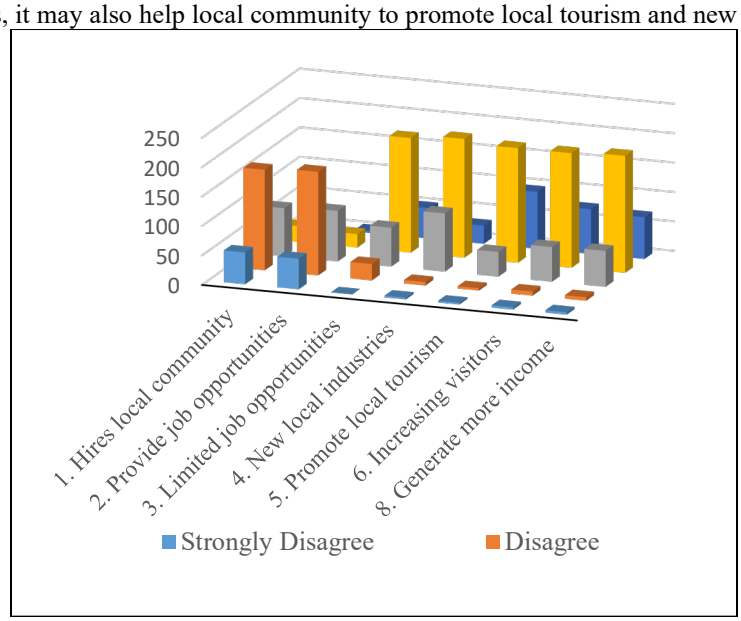

Figure 6: Sub-category results on job opportunities

4.4 Results on midpoint analysis of local community

The calculation on the midpoint analysis to identify the potential social impact in Table 4 shows that there is a significant difference between impact categories on local community by the sub-categories involved. The highest level of positive social impact obtained are safe and healthy living conditions with 82.3%, followed by local community involvement (70.9%) and lastly on job opportunities at 54.9%. The existence of the seawater desalination plant in Kampung Pantai Senok has positive implications on the local community as it provides safe drinking water continuously to them in a non-hazardous environment. The authorities also provide activities that involved both parties. The authorities need to provide training to some local communities that have the qualifications required to increase local employment opportunities.

Table 4: Midpoint analysis results

No.	The impact of local community subcategories	Percentage (%)
1.	Safe and healthy living conditions	82.3
2.	Local community involvement	70.9
3.	Job opportunities	54.9

5. Conclusion

As a conclusion, the assessment on social impacts from the life cycle of the seawater desalination process in this study has identified a few social aspects which requires improvements for the local community. The seawater desalination process activities influence the society nearby. Most of the local community had good opinions on the installation of the seawater desalination plant. The social aspects derived from S-LCA satisfied the requirements in terms of social significance. However, there are some improvements needed on the sub-categories of job opportunities for the local community. Programme and training can be provided to some local communities that have the qualifications required to contribute to local employment opportunities. Other research can be done for the rest of the seawater desalination process to get the overall potential social impact as this study only focused on three life cycle phases. The results of the study will help the plant management to reduce any negative social impacts and upgrade the efficiency of the drinking water production.

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Biography

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