A comparative study on the Environmental Impact Assessment of industrial projects in Malaysia

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Abstract. In the past decade, mankind has been manipulating the natural environment to better suit its needs for providing buildings and infrastructure for residential, commercial, business and industrial purposes. The rapid industrialization that has taken place has generated several issues regarding the environment. Therefore, managing environmental risks in construction projects has been recognized as an important process to achieve the project objectives in terms of time, cost, quality, safety and environmental sustainability. The aim of this research is to assess the environmental impact of industrial projects to the surrounding areas. The impact to the environment can be categorized into several aspects such as ecosystem impact, natural resources impact and public impact. This research employs the quantitative approach, that is, a questionnaire survey targeted at the occupants living in the surrounding areas of the case study location, namely the industrial sites in Sabah Ammonia Urea (SAMUR), Sipitang, Sabah and Lynas Advanced Materials Plant (LAMP), Gebeng Pahang. The findings of the research show that the two projects are perceived to have negative environmental impact especially for land pollution and green-house gas emissions.

1. Introduction
The construction industry is rapidly growing because of an increase in standard of living, demands for infrastructure projects, changes in consumption habits, as well as natural increase in population (Nagapan et al., 2010). A range of issues have arisen through construction activities, affecting the environment, such as harmful gases, noise, dust, solid and liquid waste (Chen et al., 2000). According to Altoryman (2014), many construction projects suffer from mismanagement despite continuous improvement in the field of project risk management. Generally, the lack of implementation of standard risk management methods in the construction industry has led to construction projects that suffer from poor performance and consequently give negative impact to the environment. The purpose of this study is to review the issues and impact of construction activities to the environment, especially for industrial projects where the likelihood of environmental deterioration occurrence may be highest. This paper begins with a review on the background of the case studies and the categories for the environmental impact assessment.

2. Case Studies
2.1 Sabah Ammonia Urea (SAMUR)
The SAMUR project is located at Sipitang Oil and Gas Industrial Park, Sabah. The project aims at strengthening PETRONAS Chemicals Group’s (PCG) position as a key regional fertilizer player,
while supporting Malaysia’s Economic Transformation Programme that focuses on the agriculture sector as part of the National Key Economic Areas. The Sabah Ammonia Urea (SAMUR) project consists of an ammonia plant, urea and granulation plant, as well as utilities and jetty facilities. The urea plant produces 1.2 million metric tons per annum (mtpa) of granulated urea and the ammonia plant produces 740,000 mtpa of liquid ammonia (Petronas.com.my, 2017)

2.2 Lynas Advanced Materials Plant (LAMP)
The Lynas Advanced Materials Plant is one of the largest and most modern rare earths separation plants in the world. The LAMP is designed to treat Mt Weld concentrate and produce separated Rare Earths Oxide (REO) products for sale to customers in locations including Japan, Europe, China and North America. The LAMP is located at the Gebeng Industrial Estate near Kuantan, Malaysia, close to the Kuantan deep-water port. The plant is built on a 100 hectares site and has been designed and built in two phases. The most valuable product produced at the LAMP is praseodymium/neodymium (Lynascorp.com, 2017)

3. Literature Review
3.1 Impact of Construction Activities towards the Environment
The environment is threatened severely by many problems, some of which are caused by the activities of construction projects (Ijigah et al, 2013). Rapid industrialization and the population explosion in Malaysia has led to the migration of people from villages to cities and thus increases human settlement in the growing cities and towns. This generates several issues related to the environment. Any development project plan to improve the quality of life has some built-in positive and negative impacts; and as such, the development project should be planned in a manner that has maximum positive impacts and minimum negative impacts to the environment (Kaur and Arora, 2012). Environmental impacts are categorized into three areas which are public impact, natural resources impact and ecosystem impact. (Li et al., 2010; Chang et al., 2011 and Zolfagharian et al., 2012)

![Environmental Impacts Diagram](image-url)

**Figure 1.** Environmental Impacts of Construction Processes (Li et al., 2010; Chang et al., 2011 and Zolfagharian et al., 2012)
4. Research Methodology

A quantitative method research approach is employed in this study to provide the basis for primary data in investigating the level of environmental impact within the surrounding areas of the case study projects.

4.1 Data Collection

The data collection method was accomplished through an on-site questionnaire survey, divided into 5 sections.

4.1.1. Research Population. Population is defined as ‘units (people, employee or members) that have the chance to be included in the survey sample’ (Groves et al., 2009). The population for both projects is the community around the site area. This community is from various villages close enough to the site to be affected by the construction activities that has taken place (SAMUR and LAMP projects).

4.1.2. Sampling Frame. Sampling may be defined as the selection of some parts of the population on the basis of which a judgment or inference about the entire population is made (Kumar et al., 2013). The community within the areas around the SAMUR and LAMP projects were considered in this research to investigate the impact of construction activities to the environment and thus, determine strategies for identifying risk factors assessment for sustainable building.

4.1.3 Instrument and Measurement

The research instrument used in this study was a questionnaire containing open – ended and closed – ended type questions. A 5-point Likert scale was used in gathering some of the data, using a measurement scale of 1-5, with 1 being “having the least impact” and 5 being “having the greatest impact”. The questionnaire uses both English and Bahasa Malaysia to ensure validity and reliability of responses.

4.2 Method of Data Analysis

4.2.1 Comparative Study. According to Goodrick (2014), comparative case studies cover two or more cases in a way to produce more generalizable knowledge and undertaken over time emphasizing comparisons within and across contexts. Comparative research can be traced to a long history that has gained much attention in current research due to globalization and technological advances on cross-national platforms (Azarian, 2011).

4.2.2 Quantitative Method. Quantitative approaches can help to provide large representative samples of communities reliably assert cause and effect relationships among constructs as well as confirm or disconfirm theoretical hypotheses and summarize numerical data (Fassinger and Morrow, 2013). Quantitative statistical analysis for the questionnaire was performed using Statistical Package for Social Sciences (SPSS) version 20.

4.2.3 Mann-Whitney. Mann-Whitney U test is a non-parametric statistical technique. It is used to analyze differences between the medians of two data sets. It can be used in place of a t-test for independent samples in cases where the values within the sample do not follow the normal or t-distribution but also when the distribution of values is unknown (Milenovic, 2011). The data for this research was analysed using Mann-Whitney statistical test to enable comparisons to be made between the two case studies of SAMUR and LAMP. In addition, the normality tests performed, that is, Kolmogorov-Smirnov and Shapiro-Wilk tests of normality, have indicated that the distribution is not normal and therefore a non-parametric test such as Mann-Whitney should be used.
5. Results and Findings
Four-hundred questionnaires were distributed and collected, with a response rate of 100%. The results for the Mann-Whitney U test for both case studies are as shown in Table 1 and 2 below.

5.1 General Environmental Concerns

Table 1. Mann-Whitney U test with Mean Rank

| Ranks                      | Activities   | N  | Mean Rank | Sum of Ranks |
|----------------------------|--------------|----|-----------|--------------|
| Site Hygiene Condition     | SAMUR        | 200| 283.07    | 56613.00     |
|                            | LAMPS        | 200| 117.94    | 23587.00     |
| Total                      |              | 400|           |              |
| Public Health Effects      | SAMUR        | 200| 257.58    | 51516.50     |
|                            | LAMPS        | 200| 143.42    | 28683.50     |
| Total                      |              | 400|           |              |
| Resource Deterioration     | SAMUR        | 200| 290.30    | 58059.50     |
|                            | LAMPS        | 200| 110.70    | 22140.50     |
| Total                      |              | 400|           |              |
| Electricity Consumption    | SAMUR        | 200| 296.38    | 59275.00     |
|                            | LAMPS        | 200| 104.63    | 20925.00     |
| Total                      |              | 400|           |              |
| Noise Pollution            | SAMUR        | 200| 233.42    | 46683.00     |
|                            | LAMPS        | 200| 167.59    | 35317.00     |
| Total                      |              | 400|           |              |
| Dust Generation (Machinery)| SAMUR        | 200| 245.08    | 49016.00     |
|                            | LAMPS        | 200| 155.92    | 31184.00     |
| Total                      |              | 400|           |              |
| Land pollution             | SAMUR        | 200| 297.39    | 59477.50     |
|                            | LAMPS        | 200| 103.61    | 20722.50     |
| Total                      |              | 400|           |              |
| Air Pollution              | SAMUR        | 200| 193.82    | 38764.00     |
|                            | LAMPS        | 200| 207.18    | 41436.00     |
| Total                      |              | 400|           |              |
| Soil Erosion               | SAMUR        | 200| 271.24    | 54247.00     |
|                            | LAMPS        | 200| 129.77    | 25953.00     |
| Total                      |              | 400|           |              |
| Water Pollution            | SAMUR        | 200| 293.78    | 58756.00     |
|                            | LAMPS        | 200| 107.22    | 21444.00     |
| Total                      |              | 400|           |              |
| Waste Generation           | SAMUR        | 200| 290.94    | 58187.00     |
|                            | LAMPS        | 200| 110.07    | 22013.00     |
| Total                      |              | 400|           |              |
| Dust Generation            | SAMUR        | 200| 256.90    | 51379.00     |
|                            | LAMPS        | 200| 144.11    | 28821.00     |
| Total                      |              | 400|           |              |
| Chemical pollution         | SAMUR        | 200| 293.75    | 58750.50     |
|                            | LAMPS        | 200| 107.25    | 21449.50     |
| Total                      |              | 400|           |              |
| Landscape Alteration       | SAMUR        | 200| 287.85    | 57569.00     |
|                            | LAMPS        | 200| 113.16    | 22631.00     |
| Total                      |              | 400|           |              |
| Toxic Generation           | SAMUR        | 200| 291.84    | 58367.50     |
|                            | LAMPS        | 200| 109.16    | 21832.50     |
| Total                      |              | 400|           |              |
| Green House Gas Emissions  | LAMPS        | 200| 235.26    | 47052.50     |
| Total                      |              | 400|           |              |
| Flooding                   | SAMUR        | 200| 294.80    | 58959.50     |
|                            | LAMPS        | 200| 106.20    | 21240.50     |
| Total                      |              | 400|           |              |
Table 2. Mann-Whitney U test Results

|                          | Mann-Whitney U | Wilcoxon W | z       | Asymptotic Significance (2-tailed) |
|--------------------------|----------------|------------|---------|-----------------------------------|
| Site Hygiene Condition   | 3487.000       | 23587.000  | -15.039 | .000                              |
| Public Health Effects    | 8583.500       | 28683.500  | -10.284 | .000                              |
| Resource Deterioration   | 2040.500       | 22140.500  | -16.074 | .000                              |
| Electricity              | 825.000        | 20925.000  | -17.614 | .000                              |
| Consumption Noise Pollution | 13417.000    | 33517.000  | -7.869  | .000                              |
| Dust Generation          | 11084.000      | 31184.000  | -9.346  | .000                              |
| Land pollution           | 622.500        | 20722.500  | 18.013  | .000                              |
| Air Pollution            | 18664.000      | 38764.000  | -1.432  | .152                              |
| Soil Erosion             | 5853.000       | 25953.000  | -13.410 | .000                              |
| Water Pollution          | 1344.000       | 21444.000  | -16.792 | .000                              |
| Waste Generation         | 1913.000       | 22013.000  | -16.353 | .000                              |
| Dust Generation          | 8721.000       | 28821.000  | -10.406 | .000                              |
| Chemical pollution       | 1349.500       | 21449.500  | -16.893 | .000                              |
| Landscape Alteration     | 2531.000       | 22631.000  | -15.730 | .000                              |
| Toxic Generation         | 1732.500       | 21832.500  | -16.557 | .000                              |
| Green House Gas Emissions| 13047.500      | 33147.500  | -6.672  | .000                              |
| Flooding                 | 1140.500       | 21240.500  | -17.782 | .000                              |

From Table 1, it can be concluded that the SAMUR project reported the highest median on land pollution, indicating that the pollution may be caused by the construction activities that have taken place. The cross-tabulation results of these variables, as shown in Table 3, shows that land pollution has affected the farmers living in the surrounding area. For the LAMP project, the highest median is on greenhouse gas emissions, which can cause global warming.

5.2 Cross Tab for Occupation and Resource Deterioration

Table 3. SAMUR cross tabulation table

| Occupation | very low effect | low effect | neutral effect | strong effect | very strong effect | Total |
|------------|-----------------|------------|----------------|---------------|-------------------|-------|
| Business   | 0               | 2          | 3              | 4             | 7                 | 16    |
| Carpenter  | 0               | 1          | 0              | 0             | 0                 | 1     |
| Farmer     | 0               | 2          | 7              | 0             | 22                | 31    |
| Fisherman  | 0               | 2          | 7              | 3             | 10                | 22    |
| Total      | 5               | 19         | 56             | 23            | 97                | 200   |

Table 3 shows that among the occupations of respondents, the strongest impact from resource deterioration is towards farmers. Resources deterioration affected the farmers’ earning because the SAMUR project produces ammonia, a chemical that, according to the respondents, has affected their fruit trees which has not been producing as well as before.
Table 4. LAMP cross tabulation table

| Occupation | Resource Deterioration | Total |
|------------|------------------------|-------|
|            | very low effect | low effect | neutral effect |
| Business   | 64               | 88      | 2              | 154   |
| Fisherman  | 15               | 13      | 0              | 28    |
| Total      | 81               | 116     | 3              | 200   |

Table 4 shows results for the LAMP project between occupation and resource deterioration. The two main occupations of the people in the surrounding area were not affected by the construction activities.

5.3 Discussion on findings
From the results, it can be shown that the environmental impact to the area surrounding the SAMUR project is more critical compared to the LAMP project, due to land and water pollution caused by chemical by-products. Based on the findings, the highest median in the SAMUR project is land pollution, followed by flooding. This is cross supported by interview data, in which the community stated that floodings frequently occur due to landscape changes and disposal of waste into the small river.

The highest median for LAMPS project is greenhouse gas emissions, followed by air pollution. Green-house gas emissions and air pollution are mostly due to the heavy smoke from the factory and also dust from the road caused by the movement of lorries transporting products in and out of the factory. Based on the interviews with the community, chemicals used by the LAMPS project also emit a foul smell which caused discomfort amongst the community.

6. Conclusion
This study investigated the environmental impact due to construction activities for two industrial sites, SAMUR in Sabah and LAMP in Pahang. The results demonstrate that land pollution and greenhouse gas emissions are the main concerns for the respondents living in the surrounding areas. These results can be a useful basis for developing assessment tools to assist construction practitioners to improve their on-site environmental performance. Furthermore, understanding the risk level of environmental impacts caused by construction processes and activities can be valuable when considering measures for mitigating such impacts, which may lead to successful sustainable performance and management. The outcomes of this study can help organizations and managers prepare proper sustainability plans and increase knowledge on levels of environmental impacts caused by industrial projects.

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