Capacity Evaluation of Environmental Noise for Airport Sustainability through Eco-Airport

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ABSTRACT

Soekarno-Hatta International Airport susceptible to various problems. Problems pile up, ranging from operational issues to non-operational. If this is not addressed, the problem will be more complicated accumulation to the risk of a big deal. These conditions will increase the risk of noise factors, the potential emergence of health problems for people who live and move in the airport area. The purpose of this study was to develop a capacity model of noise for noise control in accordance with the conditions of the airport. The study involved 240 respondents and sampling conducted by proportional random sampling. The results showed that the noise implications of the model can be constructed through the factors analysis that can give an idea of the influence of noise to society. Conclusions of this study is to model the environmental capacity of generating some indicators of noise that can be used as an instrument to evaluate, build, and develop a policy on airport noise control as a part of eco-airport performance control.

Keywords: environmental model, environmental capacity, factor analysis, noise control model, eco-airport performance evaluation

Introduction:

Referring to Law No. 1 of 2009 on Flight (State Gazette of 2009 No. 1, Supplement to Statute Book No. 4956) and the Regulation of the Minister of Transportation No. KM 11 Year 2010 About the National Order of airport affairs, stated that:

The airport is in the area of land and/or water with certain limits are used as a place of aircraft landing and taking off, up and down passengers, loading and unloading of goods, and the intra and inter-transportation movement, which is equipped with the safety and security of flight, as well as basic facilities and other supporting facilities.

While the notion of sustainable development that is environmentally conscious and planned effort, which integrates the environment, including the resources, to the development process to ensure the ability, well-being, and quality of life of the present generation and future generations. Then in 1987 the term sustainable development is defined by the development that can meet the needs of current generations without having to disrupt the ability of future generations to meet their own lives in the future (Peter, 2008).
Noise is unwanted environmental footprint of an airport environment caused by airport operations is the sound of an airplane engine noise that cause noise which affects not only the workers activities at the airport, but it also affects the people who live around the airport area. Increased levels of continuous noise from various activities in the airport environment can lead to interference noise, and other impacts of noise (Saso, 2000). Effects of noise emitted by aircraft operating at airports when using the runway was very influential in the community who live or are located around the airport, and gave rise to different perceptions in assessing the level of noise (Ernesto, 2008). Ernesto research conducted at the Ninoy Aquino International Airport - Philippines, showing the variety of respondent communities affected by aircraft noise. Length profile of respondents living in the area surrounding the airport, occupation, gender, age and household income gives a different perception of the effects of aircraft noise.

Similar conditions in Indonesia related to airport noise also showed an association between aircraft noise to the disturbance in the community. Increase the frequency of flights and increase aircraft noise will improve the risk factors, which result in potential health risks for workers at the airport (Yadnya, 2009). Yadnya research conducted in the area surrounding the Ngurah Rai Airport Bali - Denpasar, suggest a link between the level of noise and ground handling sharp hearing officer. The results showed that the sharp decline in the level of noise affect hearing.

Nelson (2003) conducted a meta-analysis of studies of airport noise and hedonic value of the land. From the research results obtained land prices in areas with noise levels of 55 dB (A) more expensive than the price of land with a noise level of 70 dB (A).

Lars Jarup. et, al. (2008). Aircraft noise is likely to cause hypertension, an important risk factor is not small in the environmental factors that have a major impact on public health, while concerns about the negative impact of aircraft noise on health, is the level of perceived interference and a sensitivity level that has the greatest risk of effects of noise disturbance (Maarten et al, 2008).

Richard (2009). Conduct research related to public transportation as well leave the noise and cause hearing loss, as well as the potential for noise exposure exceeds the quality standards that have been set, so the need for individual hearing protectors.

Daniel et, al., (2010). Relationship between environmental noise and health are poorly understood, but it is important and essential for public health. Each individual may react differently to the aggravation of the same noise, as well as individual differences in response to the noise sensitivity. Research conducted at the Auckland International Airport yielding the conclusion that the noise can degrade the quality of life because of the aggravation and lack of sleep.

Van Praag. Baarsma, (2000), conducted a study on the effects of noise nuisance around Amsterdam Airport Schiphol is internalized monetary compensation for the disorder, including a compensation scheme depends on, objective noise level, income and the presence of noise insulation.

Methodology

This research was carried out experimentally to obtain the ideal model of noise environmental capacity region airports, research will be done gradually through direct measurement of the noise level. Factor analysis was performed to see the impact of noise caused by the movement of an aircraft and its implications on society. The research framework is presented in Figure 1.
Airport Sustainability

- number of citizen
- number of passengers

Technology

- Aircraft Model
- Aircraft Type

Aircraft Movement

Noise Level

Exposure to Environmental Noise Areas

Exposure to humans capacity environmental noise

Factor Analysis

Implication of Airport Noise

Model of environmental capacity of noise

Government Policy to establish Airport Noise Level

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**Data Analysis Techniques**

According to Santoso and Fandy (2001: 250) reveals that the factor analysis is divided into four stages, that is:

1. Choosing the appropriate variables included in the factor analysis. Therefore, factor analysis seeks to group a number of variables, then there should be a fairly strong correlation between the variables, so that will happen grouping. If a variable or more weakly correlated with other variables, then these variables will be excluded from the factor analysis.

2. After a number of selected variables, then do 'extraction' variable to be one or several factors.

3. Factors formed, in many cases, less describes the differences between the factors that exist. However, if the content is questionable factors, the process can be carried out to clarify whether rotation form factor is significantly different from the other factors.

4. Once the factor actually been formed, then the process is continued by naming the existing factors.

**Result and Discussion**

The results of the analysis of secondary data obtained from the noise level monitoring manager International Airport Soekarno-Hatta taken in 2009 and in 2010 (Table 6.), Showed that the average level of noise that occur during this period are: 72.34 dB(A), and if the noise level standard for regional airports is assumed to be 70 dB(A), then the condition of airport Soekarno-Hata actually have passed the standard noise level, which means there has been unsustainable airport. While based on primary data, in March of 2011 to December of 2011, data showed the lowest noise level 60.3 dB(A) occurred in April 2012 and the highest noise level of 76.1 dB(A) occurs also in April 2012. For the
data noise level recorded at the time of the interview with the respondent, giving the distribution of noise that occurs with a range of noise by 15.80 dB(A), with the lowest noise level was recorded at 59.30 dB (A) and the highest noise level can be recorded is equal to 75.10 dB(A). Results of univariate analysis showed the level of noise generated following data:

1. Average noise level = 69.08 dB(A).
4. Maximum noise level = 75.10 dB(A).

Analysis of the implications of noise as noise environmental capacity of the natural environment, artificial environment, and the social environment by using the method of analysis - analysis of factors produces an optimal solution with 5 (five) new factor that is formed from the grouping process output and factor analysis can be interpreted as new variables: noise annoyance, noise disturbance, noise impact, noise management, and the newly formed sensitivity. Faktor noise is a response of the respondents to the presence of environmental noise that is accepted as the implications of airport noise is perceived, and through factor analysis process continued The next factor that can be obtained if the value associated with the noise level can be used to build the capacity of environmental noise function.

Table 1. Noise Level Region International Airport Soekarno-Hatta Year 2009 and 2010

<table>
<thead>
<tr>
<th>Location</th>
<th>Period and Time</th>
<th>Sem 1’09</th>
<th>Sem 2’09</th>
<th>Sem 1’10</th>
<th>Sem 2’10</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1</td>
<td>L-S dB(A)</td>
<td>72.9</td>
<td>72.9</td>
<td>72.9</td>
<td>68.7</td>
<td>71.85</td>
</tr>
<tr>
<td>West</td>
<td>L-M dB(A)</td>
<td>74.7</td>
<td>74.7</td>
<td>74.7</td>
<td>67.2</td>
<td>72.83</td>
</tr>
<tr>
<td></td>
<td>L-SM dB(A)</td>
<td>73.6</td>
<td>73.6</td>
<td>73.6</td>
<td>68.2</td>
<td>72.25</td>
</tr>
<tr>
<td>K2</td>
<td>L-S dB(A)</td>
<td>77.2</td>
<td>77.2</td>
<td>77.2</td>
<td>71.2</td>
<td>75.70</td>
</tr>
<tr>
<td>East</td>
<td>L-M dB(A)</td>
<td>48.1</td>
<td>48.1</td>
<td>48.1</td>
<td>70.0</td>
<td>53.58</td>
</tr>
<tr>
<td></td>
<td>L-SM dB(A)</td>
<td>75.4</td>
<td>75.4</td>
<td>75.4</td>
<td>70.9</td>
<td>74.28</td>
</tr>
<tr>
<td>K3</td>
<td>L-S dB(A)</td>
<td>79.9</td>
<td>79.9</td>
<td>79.9</td>
<td>77.8</td>
<td>79.38</td>
</tr>
<tr>
<td>North</td>
<td>L-M dB(A)</td>
<td>73.9</td>
<td>73.9</td>
<td>73.9</td>
<td>65.8</td>
<td>71.88</td>
</tr>
<tr>
<td></td>
<td>L-SM dB(A)</td>
<td>78.7</td>
<td>78.7</td>
<td>78.7</td>
<td>76.2</td>
<td>78.08</td>
</tr>
<tr>
<td>K4</td>
<td>L-S dB(A)</td>
<td>73.1</td>
<td>73.1</td>
<td>73.1</td>
<td>74.0</td>
<td>73.33</td>
</tr>
<tr>
<td>South</td>
<td>L-M dB(A)</td>
<td>74.8</td>
<td>74.8</td>
<td>74.8</td>
<td>60.8</td>
<td>71.30</td>
</tr>
<tr>
<td></td>
<td>L-SM dB(A)</td>
<td>74.1</td>
<td>74.1</td>
<td>74.1</td>
<td>72.4</td>
<td>73.68</td>
</tr>
<tr>
<td>Average</td>
<td>dB(A)</td>
<td>73.03</td>
<td>73.03</td>
<td>73.03</td>
<td>70.27</td>
<td>72.34</td>
</tr>
</tbody>
</table>

Implications of Noise Annoyance factor (X1) is positive, it indicates that the higher the level of noise that happens it will have implications on the increase due tingkatketidaknyamanan hear the noise. On the function of noise environmental capacity that is built, Annoyancememberikan Noise factor contributing to the changes that occur with the reception noise noise acceptance range of 5.70 dB (A), and the reduction of the maximum noise level of acceptance of 2.80 dB (A) as well as the addition level of acceptance The maximum noise of 2.90 dB (A).

Aircraft noise can be a source of discomfort for disturbing sleep, interrupting conversations, and disrupting human activity, subjective experience aggravation of a general reactions to the noise and each respondent can show different reactions to the same noise level and differences in respondents can be partly ascribed to differences in noise sensitivity.

And a strong emotional response from the direct implications of this noise can affect the health and health deficit will increase due to the emergence of discomfort to the continuous noise (Miedema, 2001), the main cause of the implications of Noise Annoyance is the noise level that it can also affect on psychological factors.
Exploration results of previous studies related to the environmental impact of airport operations activities at airports Australasia also showed figures of 17% for the problem Noise Annoyance (Daniel, 2010) and ratings Noise Annoyance aircraft on a study of 12 airports in several European countries also showed the 25% (Kaltenbatch, 2008), while in this study 20% figure obtained for the same factors.

Factors implications Noise Disturbance (X2) is positive, it indicates that the higher the level of noise that happens it will have implications on the increase due tingkatgangguan hear the noise. On the function of noise environmental capacity that is built, Noise Disturbance factors contributing to changes in the reception of noise that occurs with noise acceptance range of 6.43 dB (A), and the reduction of the maximum noise level of acceptance of 3.43 dB (A) as well as the addition level receipt of the maximum noise of 3.00 dB (A).

Noise can cause disruption and harm to health, at higher levels can cause deafness or hearing loss due to exposure to noise (Noise Induced Hearing Loss), noise nuisance factor is the most dominant disturbance variables in the study relationship between noise level with health problems (Fyhri 2008) and implications of aircraft noise is the appearance of a negative impact on health and the stress of life and can ruin the quality of life (Kaltenbach, 2008). Implications Noise Disturbance pada modes of transport, especially air transport more noise due to wind turbine performance reached 25% (Van der Berg, 2009). This indicates the need to control noise at the source of the sound.

Concerns about the adverse health implications of Noise Disturbancemerupakan as accumulated along with the emergence of new Noise Annoyance factor which has been obtained previously and the results showed 22.84% rate.

Implications Noise Impact Factor (X3) is positive, it indicates that the higher the level of noise that happens it will have implications on the increase due tingkatdampak hear the noise. On the function of noise environmental capacity that is built, Impact memberikan Noise factor contributing to the changes that occur with the reception noise noise acceptance range of 4.99 dB (A), and the reduction of the maximum noise level of acceptance of 2.73 dB (A) as well as the addition level of acceptance The maximum noise by 2.26 dB (A).

Impact on Noise implications, respondents clustered on the problem areas of airport noise situation, the presence of particles, dust, and smoke and odor as a result of the operational activities of the airport, felt by most respondents that make calculations accumulation rate becomes 32.12% Impact Noise.

Implications Impact ini Noise is a type of noise that is the implication of the residual noise is left behind.

Factors implications Noise Management (X4) is negative, it indicates that the higher the noise management efforts undertaken it will have implications on menurunyatingkat noise. On the function of noise environmental capacity that is built, Management memberikan Noise factor contributing to the changes that occur with the reception noise noise acceptance range of 6.64 dB (A), and the reduction of the maximum noise level of acceptance of 3.29 dB (A) as well as the addition level of acceptance The maximum noise of 3.35 dB (A).

Various attempts have been made through the noise management policies such as:

1. Implementation of the Integrated Noise Model (INM), is the most widely used model for the calculation of the noise level in order to analyze the pattern of aircraft noise by utilizing and processing information on a certain period of time include: the number of aircraft, aircraft type, aircraft movement frequency, and route of the runway, this model was developed by the FAA.
2. At the international level, the International Civil Aviation Organization, or the International Civil Aviation Organization (ICAO) impose increasingly stringent standards for noise emissions from civil aircraft within the airport noise management include:
   1. Noise reduction at the source of noise.
   2. Land use planning area airports.
   3. Changes in the operational procedures of airports.
   4. Restrictions on the use of noiseless noisy aircraft.
3. For Indonesia, through a decision of the Minister of Environment No. 1996 Kepmen/LH/48 about the noise level standards.

4. In particular for the International Airport Soekarno-Hatta, the Indonesian Transportation Ministry also issued a policy through the Minister of Transportation No. KM 13 of 2010 concerning the boundaries of the noise around the International Airport Soekarno-Hatta.

Based on the research results, the Management Noise factor is negative, then the noise factor management has become very important to be a concern and needs to be improved because it will have a direct impact on the reduction in noise levels and impacts on noise reduction at the source of the sound.

Implications Noise Sensitivity Factor (X5) is negative, it indicates that the higher the level of noise that happens it will have implications on menurun nyata tingkat sensitivity of human hearing. On the function of noise environmental capacity that is built, Sensitivitymbahaya Noise factor contributing to the changes that occur with the reception noise noise acceptance range of 6.45 dB (A), and the reduction of the maximum noise level of acceptance of 4.08 dB (A) as well as the addition level of acceptance The maximum noise of 2.37 dB (A).

Noise Sensitivity of hasil penyelidikan biologis dasar, diketahui sensitivitas noise has a heritability of 40% (Heinonen, 2005), and provide an overview sensitivitas kebisingan sensitive bahwa individu have distinctive patterns of brain activity that membedakan mereka of individuals who are not sensitive (Pripfl et. Al., 2006) dan pada differences in sensitivity kebisingan antarsebut, most likely reflecting a greater strain differences in cognitive processes. Based on the results of research conducted, this factor is negative, the sensitivity of the noise factor becomes very important to be a concern because it will have a direct impact on individual sensitivity and decrease impact on the health problems caused by noise.

Annoyance Noise Factor, Noise Disturbance, Noise Impact, Noise Management, and Noise Sensitivity is an environmental implications of airport noise and a noise environmental capacity to be sustained by the carrying capacity of its environment. In models built noise control, noise environmental capacity is considered as a variable demand because it has direct implications on the social environment, economic environment, and the natural environment.

Conclusion

Based on the results of the discussion and descriptions of the limitations of previous research, there are some conclusions that need to be submitted as suggestions as follows:

1. For the Department of Transportation, to control the aircraft certification which still operates in accordance with the provisions and standards of noise which refers to the office of international civil aviation (ICAO), and establishes criteria for eco-friendly airport refers to the International standards or procedures.

2. For the Ministry of Environment, in cooperation with the Department of Transportation to immediately determine the standard level of airport noise.

3. Airport for business, managing land use area airports and encourages optimal energy inovatif konsepperedaman noisy strategy and control scheme in reducing noise for society which impacted.

4. For flight operators and aviation industries, using planes with low noise technology and attention to the environmental impact of business activity or production operations performed.

5. For academics, conduct advanced research related to the pattern of airport noise, airport environmental footprint, and environmentally friendly airports criteria in accordance with the concept of sustainable development.

6. For local government, to control the use of agricultural land and land up in accordance with the function refers to the existing rules and regulations.

7. However, further research needs to be done is:
1. Analysis of components of the criteria for eco-sustainability airport airports.
2. Community involvement in the development of noise compatibility program for eco-sustainability airport airports.
3. Model eco-airport noise exposure for the sustainability of the airport.
4. Model environmental footprint eco-sustainability airport to airport.

References

Undang-undang Republik Indonesia Nomor 23 tahun 1997 tentang Pengelolaan Lingkungan Hidup
Undang-undang Republik Indonesia Nomor 01 tahun 2009 tentang Penerbangan
Peraturan Pemerintah No. 40 Tahun 1995 Tentang Angkutan Udara
Peraturan Pemerintah No. 41 Tahun 1999 Tentang Pengendalian Pence- maran Udara
Peraturan Pemerintah No. 03 Tahun 2001 Tentang keamanan dan Keselamatan penerbangan
Peraturan Pemerintah No. 70 Tahun 2001 Tentang Kebandaradaraan


UU RI Nomor: 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup.


