

## **Environmental sustainability: the case of the Sultan Hasanuddin International Airport, Makassar, South Sulawesi**

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**ABSTRACT:** This study aims to evaluate the existing condition of the sustainability of the Sultan Hasanuddin International Airport in Makassar, South Sulawesi, Indonesia, as being environmentally friendly *eco-airport* by using the rapid appraisals airport (RAP-BSHas) model. The research was conducted as a survey using multi-dimensional scaling techniques to measure the value of the sustainability index and the sustainability status. The process was undertaken to identify sensitivity attributes that affect the sustainability index in several dimensions: environmental, socio-cultural, economic, technological and knowledge, and to analyse the dominant attributes that affect the indicators of eco-airport. The results showed the sustainability index value of the environmental dimension was 62.78, the socio-cultural dimension was 31.82, the economic dimension was 51.12, the technology dimension was 65.16, and the knowledge dimension was 44.06. The value of sustainability index averages of 50.99 and 50.52 indicate that their status is *reasonably sustainable*.

### INTRODUCTION

Airports need to be managed in a sustainable manner, so the concepts of planning, development and environmental monitoring should be introduced. The concept of the eco-airport is one that is planned, developed and operated with the aim of creating transportation infrastructure that is environmentally friendly. Application of the concept of an environmentally sound aerodrome is to reduce the ratio of environmental pollution around airports.

To achieve an airport environmentally friendly (eco-airport), sustainable measurements are required, and the concept of sustainable development can provide problem-solving achievements of eco-airport. The development must prioritise sustainable infrastructure and means balancing and integrating of the physical aspects the neighbourhood, both socio-cultural and economic [1].

The concept of sustainability has evolved into a wide range of other issues in a comprehensive manner. In addition to environmental issues (waste gas emissions, climate change, biodiversity, habitat protection, aesthetics), other issues, such as the economy (productivity, activation of economy, labour) and social (equity, health, cultural values, public participation) are also important [1].

Indonesian Act 23 of 1997 [2], concerning the management of the environment, stated that sustainable development is an environmentally conscious and planned effort that integrates the environment, including resources, into the development process to ensure the ability, well-being and quality of life of the present generation and future generations. Another opinion is that development should meet the needs of the present without compromising the ability to meet the needs of future generations.

Sustainable development should pay attention to the environment and the preservation of the environment, so that environmental quality is maintained, so that the carrying capacity of the environment is not diminished or lost. The meaning of sustainable development is that the social justice from generation to generation has been reached. The approach used to assess sustainable development can be seen in several dimensions, including the ecological, economic and socio-cultural, and other dimensions. Dalal-Clayton and Bass as referred to by Nurmalina, assessed sustainable development through six dimensions; namely, ecological, economic, socio-cultural, institutional, political and security [3].

Other material in the literature has included the technological dimension of sustainable development to the other criteria mentioned. For example, in Thailand, the sustainable development approach has been developed across six dimensions: i.e. the ecological, economic, social, technological, social and ethical dimensions. Therefore, approaches to the assessment of sustainable development vary in line with the system or object under study.

In this study, five dimensions have been used for assessing environmentally friendly airport (eco-airport) status at the Sultan Hasanuddin International airport. These five dimensions are environmental, socio-cultural, economic, technological and knowledge, and are related to the object of study of environmentally friendly airports (eco-airport). Therefore, it takes effort to harmonise the approach to these five dimensions in order to achieve the eco-airport status for the Sultan Hasanuddin International airport.

The rapid appraisals airport (RAP-BSHas) model is a modified version of the rapid appraisals for fisheries (RAPFISH) [4], which was developed at the University of British Columbia in Canada to evaluate the sustainability of fisheries. Furthermore, the approach with the RAP-BSHas model is used to evaluate the sustainability of the Sultan Hasanuddin International Airport (RAP-BSHas) through the method of *multi-dimensional scaling*.

The Sultan Hasanuddin International Airport is the gateway to flights in eastern Indonesia. It is the object of this study, because of the location of the Sultan Hasanuddin International Airport is not included in the category of the Eco-airport Council. Currently, there are five airports that form the Eco-airport Council; namely, the Hang Nadim Airport in Batam; Sultan Muhammad Badaruddin II in Palembang; Soekarno-Hatta Banten in Jakarta; Juanda Airport in Surabaya and Ngurah Rai Airport in Bali's Denpasar.

In general, the purpose of this study is to evaluate the sustainability of environmentally friendly airport (eco-airport) at the Sultan Hasanuddin International Airport (BSHas). Specifically, the aims are to:

- assess the sustainability index and status BSHas;
- assess the sustainability index of each dimension (environmental, socio-cultural, economic, technological and knowledge);
- identify the attributes that affect BSHas sensitivity.

## RESEARCH METHODS

The survey method with RAP-BSHas modelling has been used in this research. The study was conducted from April to May 2015. The analysis included engineering ordination; using RAP-BSHas through the method of multidimensional scaling (MDS) to determine the value of the sustainability index and the status of sustainability of the environmentally friendly aerodrome (eco-airport) at BSHas; and to identify attributes that influence the sustainability index in each dimension (environmental, socio-cultural, economic, technological and knowledge) through the leverage analysis; as well as prospective analysis to determine the dominant attributes that affect the eco-airport BSHas. The MDS approach gives stable results compared to the double variable method, such as factor analysis [4].

To obtain the scale of each indicator, the experts executed a questionnaire to 21 airport staff members at the Sultan Hasanuddin International Airport. The five dimensions used in the approach to sustainability at the Sultan Hasanuddin International Airport are environmental, socio-cultural, economic, technological and knowledge.

From an environmental standpoint, the basic principles refer to the arrangement of open space, the ecological function of which is to reduce noise, based on the decision of the Minister of Environment of Indonesia, No. KEP-48/MENLH/11/1996 [5], air pollution, based on the Regulation No. 41 of 1999 [6] and a terminal building with energy efficiency (electricity and water). From the socio-cultural viewpoint, the basic principles refer to the public perception of the Sultan Hasanuddin International Airport management.

From an economic standpoint, the basic principles that refer to BSHas management relate to the economic value and utilisation levels that support the environmental conservation efforts. From a technological standpoint, basic principles refer to the facilities/infrastructure at the Sultan Hasanuddin International Airport (guided by the Ministry of Communications Decree of Indonesia, No. 44 year 2002) [7]. From the viewpoint of the knowledge gained of the basic principles that draws on the knowledge or understanding of the management, the Sultan Hasanuddin International Airport is environmentally friendly.

The stages of the research were:

1. The determination of attributes. In this study, there are 61 attributes (indicators) that include five dimensions consisting of 11 environmental indicators, 12 socio-cultural indicators, 13 economic indicators, 12 indicators of technology and 13 knowledge indicators.
2. Assessment of each attribute in ordinated scale (scoring) based on sustainability criteria for each dimension.
3. Analysis of RAP-BSHas ordinated with the MDS method.
4. Assess the sustainability index and status; BSHas studied both multi-dimensional and in every dimension.
5. Sensitivity analysis (leverage analysis) to determine the attributes that affect the sustainability sensitive.

Sustainability data analysis is described in the *diagram kites*, which gives an overview level of sustainability or sustainability status of each dimension. The further scale sustainability index of the system under study have an interval of 0 % - 100 % [3], as shown in Table 1.

Table 1: Category index and the sustainability status at airport.

Index value	Category
0.00 - 25.00	Unsustainable
25.01 - 50.00	Less sustainable
50.01 - 75.00	Sustainable enough
75.01 - 100	Sustainable

## RESEARCH RESULTS

Results of the RAP-BSHas multidimensional analysis using techniques ordinated through the method of multi-dimensional scaling (MDS) produce a value of each dimension, as shown in Table 2 and Figure 1.

Table 2: Analysis sustainability index result BSHas.

No	Dimension	Index value
1	Environment	62.78
2	Social of culture	31.82
3	Economic	51.12
4	Technology	65.16
5	Knowledge	44.06

Table 2 and Figure 1 show the BSHas sustainability value for each dimension; namely, the environment 62.78 category is quite sustainable; the socio-cultural category (31.82) is less sustainable; the economic category is sustainable enough (51.12); the technology category (65.16) is also sustainable enough, but the knowledge category (44.06) has less sustainability.

An average of 50.99 means that the overall situation is quite sustainable. Along with that, BSHas got the first position index for customer satisfaction (customer satisfaction index/CSI version of the Airports Council International (ACI)); so, it received the highest rating for *excellent service category, unit services - airport passenger terminal* [8].

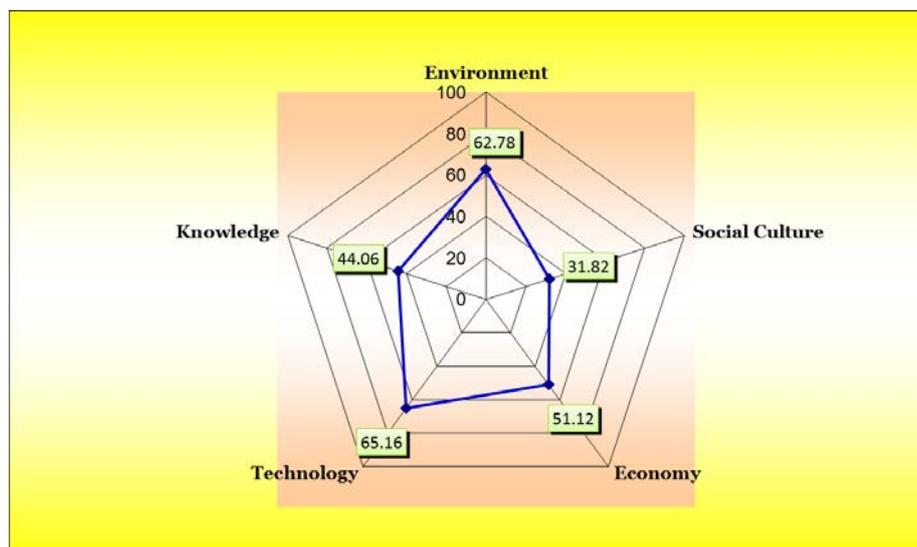


Figure 1: Analysis results and status sustainability index for the BSHas eco-airport.

The technology dimension has the highest sustainability index compared with the other four dimensions. This happens because the general management of BSHas related to technology and management is good enough. As the use of environmentally friendly building materials in the terminal, of the type of crops used in open spaces, 80% is composed of plant species, which serve to reduce noise, and sewage treatment uses wastewater treatment plant (WWTP).

Check-in facilities are adequate, so that passenger queuing services average less than 15 minutes, faster than the standard of service set by the regulator, i.e. a maximum of 20 minutes. Similarly, the process of check-in service can be completed in less than 2 minutes or 0.5 minutes faster than the standard 2.5 minutes [9].

The socio-cultural dimension was the lowest. This happens because people's airport habits in everyday activities have not characteristically been environmentally friendly. Smoking and litter management is not in place, such as in the arrival hall basement. The habit of using air conditioning (AC) in the room even when it is not needed, and customs officers in the apron not wearing a safety equipment (e.g. masks and earplugs) had an impact on the results in 2015.

The results of earlier research, found cigarette butts and dust thick on the terminal floor, especially, in the forecourt of the passenger terminal near the arrival gate. Lack of awareness of some of the passengers, for example by arbitrarily throwing trash and cigarette butts anywhere in the departure and arrival areas of the terminals requires the introduction and improvement in maintaining cleanliness [9].

Table 3: Sustainability status of the Sultan Hasanuddin International Airport.

Dimension	Expert 1	Expert 2	Expert 3	Expert 4	Weight combined	Weight weighted	Aspect value BSHas	Average value
Environment	1.1724	0.8991	1.8887	2.0089	1.4142	0.3209	62.78	20.15
Social culture	1.6552	0.7295	1.6312	1.4679	1.3040	0.2959	31.82	9.42
Economic	0.1923	1.2023	0.6086	0.3081	0.4563	0.1035	51.12	5.29
Technology	1.6645	0.6672	0.4506	0.4742	0.6979	0.1584	65.16	10.32
Knowledge	0.3157	1.5020	0.4209	0.4091	0.5345	0.1213	44.06	5.34
Average	5.0000	5.0000	5.0000	4.6683	4.4069	1.0000	254.94	50.52
Status BSHas	Good							

Table 3 presents the status sustainability of the Sultan Hasanuddin International airport eco-(airport). After an assessment of the merger of the five dimensions, a mean value of 50.52 means that the BSHas status is *fairly sustainable*.

## DISCUSSION

Evaluation of the existing condition of the BSHas sustainability on the five dimensions assessed, can be described as follows.

### Environment Dimension

As can be seen in Figure 2, RAP-BSHas ordinated analysis results for the sustainability index in the eco-airport environmental dimension are within the interval 50-60, indicating a quite sustainable status. This is partly caused by the management of the Sultan Hasanuddin Airport requirements being met. The eco-airport terminal building has licensed material, which is environmentally friendly and in open spaces, 80% of plant species serve to absorb air pollution and reduce noise.

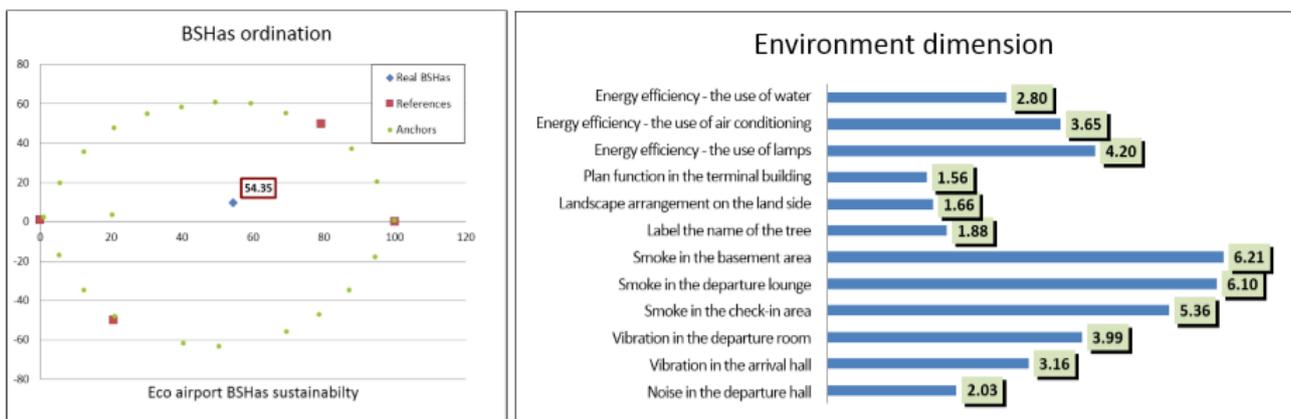


Figure 2: RAP-BSHas ordination and sensitive factors that affect the sustainability of the environmental dimension.

Results of the analysis of leveraging sustainability in the environmental dimension indicate that of the 12 attributes analysed, five are attributes that are sensitive areas that affect the eco-airport:

- smoke in the arrivals area/basement;
- smoke in the departure lounge;
- cigarette smoke in the area of the room check-in;
- the efficiency of energy use of light;
- energy efficiency of the use of air conditioning.

Three of these attributes relate to cigarette smoke, which requires good handling; namely, adequate smoking rooms in the arrival area/basement, in the departure lounge and check-in, and near the food stalls. In addition, the enforcement of regulations at the airport is required. Two other attributes; namely, lighting and air conditioning efficiency could be improved by turning off the lights or air conditioning when they are not needed or by installing low wattage lighting.

If this fifth attribute receives attention and is managed properly; then, the value of this dimension of sustainability will increase in the future.

### Socio-cultural Dimension

RAP-BSHas ordinated analysis results in the eco-airport BSHas sustainability index for the socio-cultural dimension can be seen in Figure 3. The result falls within in the 25-30 interval and has a less sustainable status. This is partly caused by the habit of the airport community throwing garbage in inappropriate places, especially in the basement, not turning off the AC when it is not needed and officers not using a mask and earplugs.

Results of the analysis of socio-cultural sustainability, it should be noted that of the 12 attributes analysed, five are have an impact on the eco-airport; namely:

- the custom of taking out the trash;
- the habit of using AC;
- airport officials not wearing a mask;
- activities that disturb the airport;
- labelling of trees in open spaces.

Two of these attributes have the same problems; namely, the habit of not throwing trash in the places space provided (primarily in the departure area and the arrival area/basement), and the airport officers who do not wear a mask and earplugs. Enforcement of regulations is a must. Taking advantage of air conditioning when not needed and labelling of trees (tree species name and function) to familiarise the public with the function of environmental education. To improve the sustainability index of this dimension, management attention is needed.

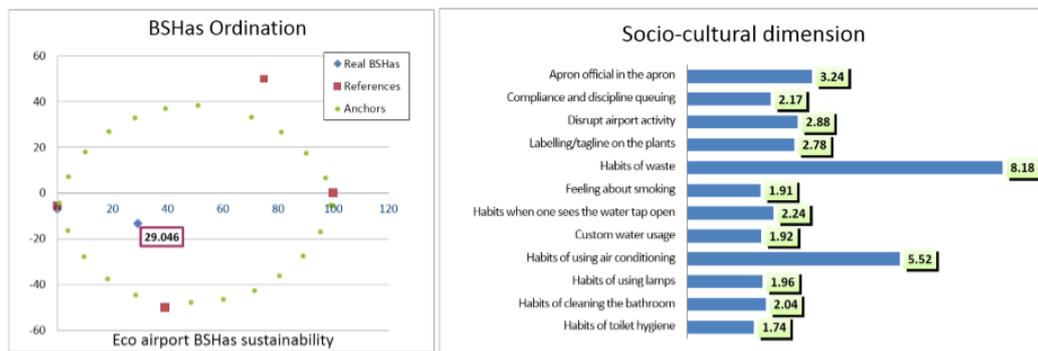


Figure 3: RAP-BSHas ordination and sustainability status affect sensitive factors of the socio-cultural dimension.

### Economic Dimension

RAP-BSHas ordinated analysis results in the eco-airport economic BSHas sustainability index for the economic dimension can be seen in Figure 4. These are at an interval of 50-60 and are quite sustainable. It is necessary to improve recycling and the comfort level in the departure lounge, which is not good, partly due to sound from speakers or megaphones.

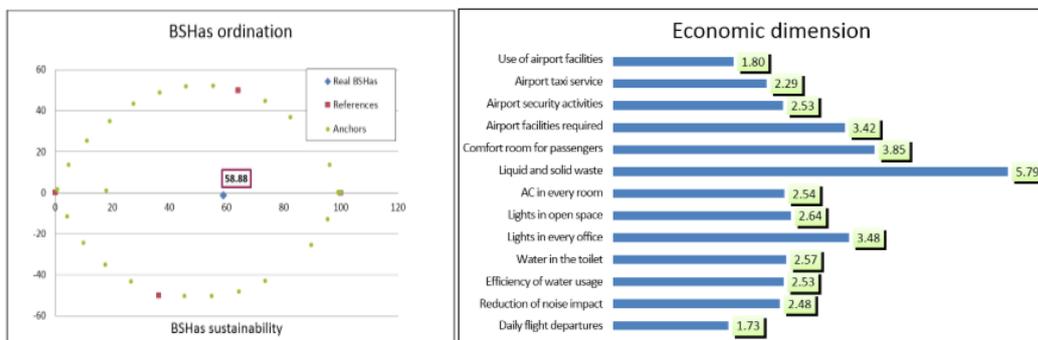


Figure 4: RAP-BSHas ordination and sustainability status affect sensitive factors of the economic dimension.

From the results of the analysis of economic sustainability, it is known that from the 13 attributes analysed, five have an impact on the eco-airport, namely;

- liquid and solid waste;
- comfort in the departure lounge;

- lights in the offices;
- the need for facilities on the air side;
- the water in the toilet.

Three attributes; namely, solid waste, the lights in the office and the water in the toilet must be managed properly in order to have an impact on the economic value. The comfort of passengers in the departure lounge is affected by sound speakers that are used for providing information to passengers, causing the passenger area to be noisy. The information system should be changed by using running text on screens, among other things. Facility upgrades on the air side to increase the quality and quantity, will have an impact on aircraft movement to make it fast and efficient with respect to time.

### Technology Dimension

RAP-BSHas ordinated analysis results in the eco-airport BSHas sustainability index for the technology dimension can be seen in Figure 5. Results are in the interval 55-60, meaning it has a quite sustainable status. Among other ways to improve the sensitivity factors; namely, waste management technology through incinerator use and comfort in the departure lounge need to be improved, because noise, voice sound speakers or megaphones are disturbing.

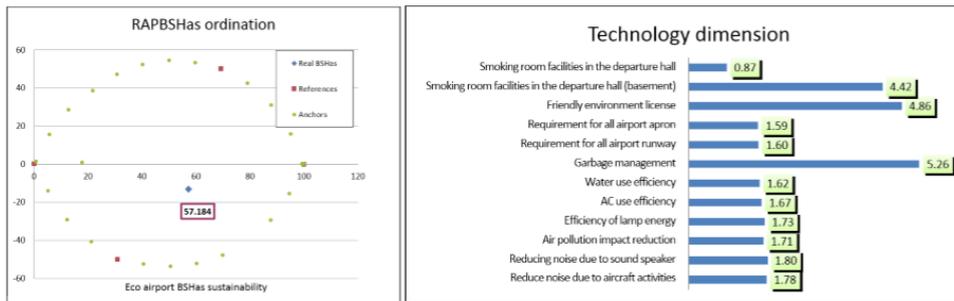


Figure 5: RAP-BSHas ordination and sensitive factors affecting the sustainability dimension of technology.

Results of the analysis of sustainability of the technology dimension, indicate that of the 12 attributes that were analysed, five attributes have a sensitive impact on the eco-airport; namely:

- waste management;
- licensing environmentally friendly materials;
- smoking room facilities;
- reducing the noise;
- energy efficient lamps.

Waste management processing is required, so that waste can be used again. Every day, as much as 15.5 m<sup>3</sup> to 19 m<sup>3</sup> of garbage is produced, comprising 51% of plastic waste, aluminium cans and paper, 49% junk food scraps and other garbage. Combustible garbage is separated and burned in the environmentally friendly incinerator. Through this process, dust combustion products will be generated. The use of licenced environmentally friendly materials, smoking room facilities, reduced noise through the use of materials that can absorb the noise or line of green plants, light energy efficiency through the use of energy saving lamps, are required. Management of these attributes well will improve the sustainability index of this dimension.

### Knowledge Dimension

RAP-BSHas ordinated analysis results for the knowledge dimension at the Sultan Hasanuddin International Airport can be seen in Figure 6. These are in the 25-35 interval and, therefore, have a less sustainable status. This is partly caused by the garbage from the Sultan Hasanuddin International Airport not being recycled and the comfort level in the departure lounge is not good, partly due to noise from sound speakers or megaphones.

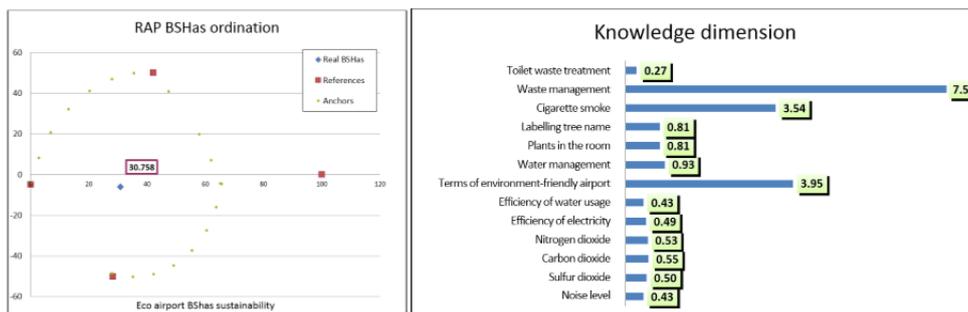


Figure 6: RAP-BSHas ordination and sensitive factors affecting the sustainability dimension of knowledge.

Results of the analysis of sustainability of the technology dimension, show that of the 13 attributes that were analysed, five attributes have a sensitivity impact on the eco-airport; namely:

- the waste;
- the terms of eco-airport;
- water;
- labelling the names of trees;
- plants in open spaces.

By providing public understanding and knowledge of airports, the benefits to five of these attributes would increase the sustainability index of this dimension in the future.

## CONCLUSIONS

The results show that the existing index value of sustainability of the Sultan Hasanuddin International Airport (eco-airport) for the environmental dimension are of 62.78; socio-cultural dimension are of 31.82; economic dimension are of 51.12; technology dimension are of 65.16; and knowledge dimension are of 44.06. The value of the sustainability index eco-airport BSHas averages 50.99, and in determining the status of the obtained value of 50.52, the sustainability is deemed as *enough* (sufficient ongoing).

The results of the analysis identified five dimensions that are dominant sensitive attributes that affect the sustainability index of the Sultan Hasanuddin International Airport. The eco-airport environment dimension is smoke in the arrivals area/basement, the socio-cultural dimension is the habit of throwing garbage in the arrivals area/basement, the economic dimension is the comfort of passengers in the departure lounge, the technological dimension is the waste management (not recycled) and the dimension of knowledge is waste.

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