Green Concept of Kulon Progo Airport Development using UMI Simulation

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Article Info

Article history:

Received May 25, 2023
Accepted May 30, 2023
Published May 31, 2023

Keywords:

Emission
Airport
simulation

ABSTRACT

High energy consumption on the airport becomes a very crucial issue nowadays. Uninterruptable energy supply is required to support airline's activity and keep the passenger convenience. Regarding the mentioned problem, there is a need to enhance the current plan of the airport with green airport concept. Green airport concept also known as eco-airport is an airport that adopted green and sustainable ecosystem concept to integrate community and environment that lead to reduction of energy consumption. The blueprint of Kulon Progo airport with green concept located in D.I. Yogyakarta, Indonesia has been made and the construction started in the mid of 2016. The airport has a FAR of 0.16 with 637 hectares land area. This study is simulating the plan to assess the energy consumption and CO_2 emission in each part of the building in Kulon Progo Airport using Urban Modeling Interface simulator. From the results, it can be seen that the passenger terminal building is responsible for the highest share with 1,351,861.01 Kwh while second floor of ATC building has the highest CO_2 emission 2,679.77 $kgCO_2/m$

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1. INTRODUCTION

Eco-airport concept is a concept that creating or strengthen the policy and critically oversight the airport operations and environment quality which intended to assess the status of environmental management of airports[1]. While, ecological engineering can be defined as the design of sustainable ecosystems that integrate the human society and the environment[2], [3]. There are four research areas related each other in ecological engineering, namely:

a. industrial ecology,
b. green engineering,
c. ecological engineering, and
d. earth systems engineering

The environmental issues are very complex issue and consists of several object, such as the environment it self, protection, and preservation environmental. While, ecology including system dynamic ussually influenced by the global environment, population and biodiversity. The main purpose of eco-airport is to prevent and reduce noise pollution to the airport surrounding, utilize the extensive use of area around airports, develop regional relationships to other airports, and develop harmony on its territory. The implementation of eco-airport can be done by changing the mindset and behavior, applying knowledge, and improving the technology of civil aviation and airport managing management which based on the environment[4], [5].

Japan Narita airport is the first eco-airport that success to reduce the ratio of environmental pollution around airports that may affect the airport operations. It is followed by Changi airport in Singapore and Kuala Lumpur International Airport in Malaysia. The eco-airport component consists of noise, vibration, atmosphere, water, soil, waste materials, energy, and Safety Flight Zone Operations and Community Health while environmental management at airports would follow the rules made by environmental management on the country by adopting the world environmental rules prevail. Some laws that must be followed by the management of airports are the rules made by ICAO (International Civil Aviation Organization) and the FAA (Federal Aviation Administration) and other rules that prevail in the world[6], [7] This study simulates the eco-airport concept in KulonProgo, Yogyakarta Indonesia using Rhinoceros. Rhino is a NURBS based 3D modeling program (NURBS) and UMI (Urban Modeling Interface) to understand energy use. The development of Kulon Temon areas is rather than along the coast Congot and Glagah area of 736 hectares. With the Spline or UMI curve in the simulation software will give you a line on the circle and the radius (multi radius) with the result of the type of smooth curves and smooth as it held the geometry of the aircraft body. Rhino NURBS method in the development of conventional spline method generally can describe the form of a mathematical model of a free and standard forms or primitive object[7]–[9]. This method is very important to create a model organized to surface quality because it depends on the smoothness of the surface.

Figure 1. Study area, KulonProgo, Yogyakarta Special Province, Indonesia

2. RESEARCH METHOD (10 PT)

Simulation method used in this study is to determine the condition of the sustainability of the region. According to Groat and Wang, simulation method is very useful when the research is dealing with the scale and complexity[10], [11]. Simulation is used to simulate the real situation as an artificial state both the micro and macro. By using a simulation method, research can obtain a wide range of information that could be used to predict the conditions in the future[12], [13]. The differences between the experimental and simulation are on research capabilities. Simulation is usually not evident in recognizing the causal relationship in the real world and often involve variables and interactions that are difficult to identify precisely. The simulation method in this study is proceed by following three step namely:(1)calculating energy requirements and CO2 emissions in the airport, (2) measuring the sustainability of an area by integrating Rhinoceros and UMI, and (3), determining the energy use in the airport by applied UMI. The first step is collecting data to support the model building, such as field observation, interviewing and documenting through photographs. It is useful to govern the eco-airport concept theory and simulate it into software[14]–[17]. The research flow for the title "Green Concept of Kulon Progo Airport Development Using UMI Simulation" can be outlined as follows:

1) Introduction
   a. Provide an overview of the importance of green concepts and sustainability in airport development.
   b. Introduce Kulon Progo Airport as the specific focus of the study.
   c. State the research objectives and the significance of applying UMI (Urban Microclimate Simulation) in the context of green concept development.

2) Literature Review
   a) Review previous studies and research related to green concepts in airport development and the use of UMI simulation.
   b) Discuss the key concepts, theories, and methodologies used in the field.
   c) Identify gaps or limitations in the existing literature that the current study aims to address.

3) Methodology
   a) Describe the research methodology and approach used in the study.
   b) Explain the UMI simulation tool and its application in assessing the green concept of airport development.
   c) Provide details on data collection methods, such as site surveys, data measurements, and input parameters for the simulation.

4) Data Analysis and Results
   a) Present the collected data and input parameters used in the UMI simulation.
   b) Perform the UMI simulation to evaluate the green concept of Kulon Progo Airport development.

c) Analyze the simulation results and interpret the findings related to various aspects of sustainability, such as energy efficiency, carbon footprint, and environmental impact.

5) Discussion
   a) Discuss the implications of the simulation results in the context of green concept development for Kulon Progo Airport.
   b) Compare the findings with existing standards, guidelines, or best practices in sustainable airport design and operation.
   c) Address the strengths and limitations of the UMI simulation approach and suggest areas for future research or improvement.

6) Conclusion
   a) Summarize the key findings of the study regarding the green concept of Kulon Progo Airport development using UMI simulation.
   b) Emphasize the significance of the research in promoting sustainable airport development practices.
   c) Provide recommendations for policymakers, airport authorities, and relevant stakeholders to integrate green concepts into the airport development process.

3. RESULTS AND ANALYSIS

The total area of Kulon Progo regency is 58.627.512 ha which covers 12 districts with 88 villages, and 917 sub-districts (table 1).The development Plan of airport facilities to meet the needs of flight operations and airport services will be undertaken primarily by the development of air freight traffic (table 2).

Table 1. Name, Area of Districts and total of Village

Districts	Total of Village	District Area	
		(Ha)	(%)
Temon	15	3,629.890	6.19
Wates	8	3,200.239	5.46
Panjatan	11	4,459.230	7.61
Galur	7	3,291.232	5.61
Lendah	6	3,559.192	6.07
Sentolo	8	5,265.340	8.98
Pengasih	7	6,166.468	10.52
Kokap	5	7,379.950	12.59
Girimulyo	4	5,490.424	9.36
Nanggulan	6	3,960.670	6.76
Kalibawang	4	5,296.368	9.03
Samigaluh	7	6,929.308	11.82
Total	**88**	**58,627.512**	**100**

Table 2. Air Transport Services Demand Forecast of New Airport in KulonProgo

No.	Description	Demand
I	Passengers (per-year)	
1.	Domestic	9,132,000
2.	Internasional	868,000
	Total	**10.000.000**
II	Cargo (ton/year)	
1.	Domestic	30,240
2.	Internasional	1,370
III	Aircraft movements (per-year)	
1.	Domestic	67,200

2.	Internasional	5,460
IV	Passenger peak hour (per-hour)	
1.	Domestic	3,222
2.	Internasional	632
V	Aircraft peak hour (per-hour)	
1.	Domestic	21
2.	Internasional	4

3.1 Future Needed Facilities

There are 4 points to develop a new Kulon Progo airport:

1. Based on New Airport Master Plan in Kulon Progo by the Minister of Transportation, EEMangindaan
2. An environment assessment (AMDAL) must be done first.
3. Detailed engineering design for the implementation of the construction and development of airport facilities approved by the Director General.
4. The construction and development of airport facilities implemented by considering priority funding needs and capabilities in accordance with the exist legislation.

Table 3 Development Plan and Development Stages of New Airport in Kulon Progo Regency

No.	Description	Development	Units
I	**Air-side Facilities**		
1.	Aircraft	B 747-400	Aircraft
2.	Runway Orientation	11-29	
3.	Runway	3,250x45	m^2
4.	Stopway (Runway 11/29)	60x45	m^2
5.	Runway End safety Area (Runway 11/29)	90x90	M
6.	Declared RW		
	TORA (Runway 11/29)	3,250	M
	LDA (Runway 11/29)	3,250	M
	ASDA (Runway 11/29)	3,310	M
	TODA (Runway 11/29)	3,460	M
7.	**Runway Strip**	**3,370x300**	**m^2**

8.	Exit Taxiway	5,204	m^2
9.	Rapid Exit Taxiway	29,135	m^2
10.	Holding Bay	45.914	m^2
11.	a.Paralel Taxiway 1	3,250x23	m^2
	b. Paralel Taxiway 2	-	m^2
12.	Taxiway Separation		
	a. As taxiway-runway	190	M
	b. AS Taxiway paralel-AS Taxiway paralel	97.5	M
13.	Apron Capacity		
	a. Parking Stand		
	- Code C Aircraft	27	Aircraft
	- Code E Aircraft	1	Aircraft
	b. Contact stand		
	- Code C Aircraft	10	Aircraft
	- Code E Aircraft	1	Aircraft
18.	Crisis Control Building	400	m^2
19.	Airport Maintenance Building	5,000	m^2
20.	Pollice Office	250	m^2
21.	Security Office	250	m^2
22.	Hangar	16,000	m^2
23	GSE Maintenance Building	2,000	m^2

3.2 Simulation result

3.2.1 Site FAR

The FAR site is the ratio between the floor area of the building with an area of land. The FAR regulations will affect the skyline created by a collection of buildings around the airport. The purpose of the determination of the FAR is associated with the right of every person or building to receive sunlight. If the building has the same height with the building besides, it means that the building can receive sunlight like existing buildings next to it. KulonProgo Airport has FAR value of 0.16.

3.2.2 Total Electric Energy

The requirement for Total Electric Energy in Kulon Progo airports per-month for each building is different due to different site of area. The highest electric econcumption is about 5,441,139.33 Kwh happened on August at area development building as shown in Figure 3.

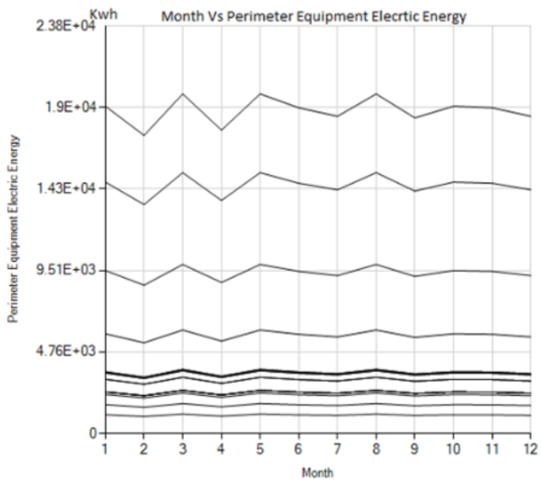

Figure 3. The Total Electric Energy Graphic

3.3.3 Heating Perimeter

The heating perimeter for each building is different, depending on the size of the building area and building materials. The highest heating perimeter is 21796.72 Kwh January that happened by Area Development Facility building. While at May and Sept the heating is not reguired as the country is in dry season as shown in figure 4.

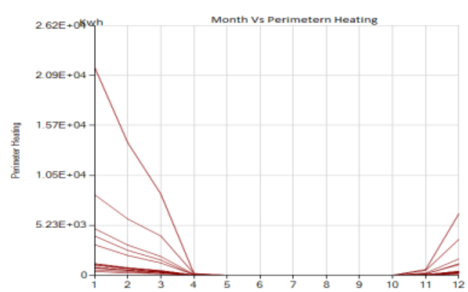

Figure 4. Heating Perimeter Graphic

3.2.4 Cooling Perimeter

The Cooling Perimeter for each building is different, and is influenced by the cooling requirements of the building. The highest cooling perimeter is 172,312.93 Kwh in July of the Area Development Facility building. While, the lowest is 258.26 Kwh in January by VVIP buildings, as shown in Figure 5.

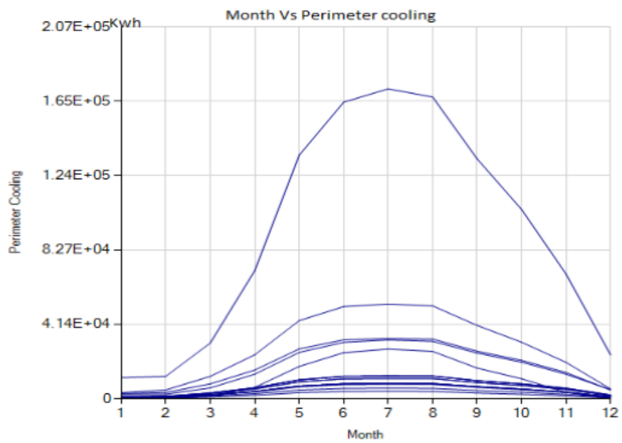

Figure 5. Cooling Perimeter Graphic

3.2.5 Lighting Perimeter

The Lighting Perimeter is a lighting that needed by every building and influenced by the size area of the building. On the construction of several buildings in Kulon Progo airport, the Facilities Development Areas building need the largest lighting at 4483.34 Kwh and the lowest found in VVIP building of 1193.47 Kwh, as shown in Figure 6.

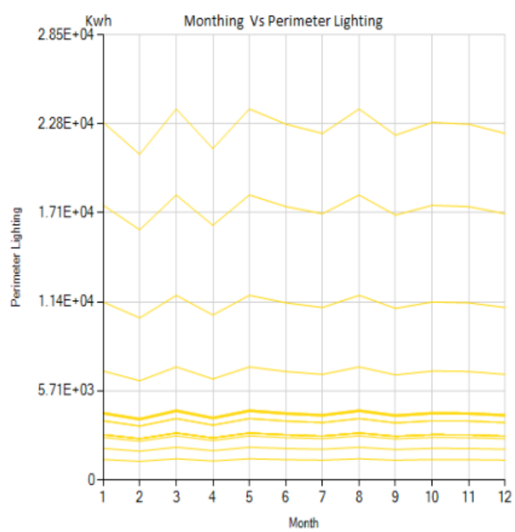

Figure 6. Lighting Perimeter Graphic

3.2.6 The CO_2 Emission

The CO_2 emission is influenced by the building materials and height of buildings at Kulon Progo airport, which is calculated based on the amount of CO_2 in the building area per square meter. The highest Emissions is about 2679,77 $kgCO_2/m^2$ has been found ATC second Floor building as shown in Table 4.

Table 4. The CO_2 Emission

No.	Name of Buildings	Kwh /m²	$KgCO_2/m^2$
1	Fuel Station	5167.48	362.96

2	Utility Area	5006.89	350.53
3	Government Building	5460.35	381.47
4	Administration Airport Building	5460.35	381.47
5	VIP Building	6070.54	423.11
6	ATC first floor building	5460.35	381.47
7	ATC Second floor building	6070.54	679.77
8	PKP-PK	6781.15	403.30
9	Passenger Terminal	5117.95	358.10
10	Haji Terminal	5492.97	383.66
11	Catering Building	5398.88	377.27
12	Cargo Terminal Building	5398.88	377.27
13	Airport Maintenance Building	5299.98	370.51
14	Aircraft Maintenance Building	6167.56	430.27
15	Facility DevelopmentAirport Support Area	5330.73	373.16

3.2.7 Mobility

Mobility is a movement of the occupant of the building to other buildings in Kulon Progo airport where the movement is done by walking and cycling. The value of mobility every building is different and the highest mobility are done by passenger terminal building, Haji terminal building and catering building with mobility value of 49% (pedestrian).

Table 5. The Mobilty between Buildings

No.	Name of Buildings	Pedestrian (%)	Cyclists (%)
1	Fuel Station	23	8
2	Utility Area	1	1
3	Government Building	43	16
4	Administration Airport Building	43	14
5	VIP Building	43	14
6	ATC first floor building	43	16
7	ATC Second floor building	43	16
8	PKP-PK	3	3
9	Passenger Terminal	49	6,3
10	Haji Terminal	49	34
11	Catering Building	49	33
12	Cargo Terminal Building	46	32
13	Airport Maintenance Building	46	23
14	Aircraft Maintenance Building	46	28

15	Facility DevelopmentAirport Support Area	6	1

4. CONCLUSION

The development of Kulon Progo airport has a FAR site of 0.16 with a land area of 637 hectares. Total electric energy required by Kulon Progo airport per-moth are different for each building because every building has different size of area. The total electric energy in the passenger terminal building at 1,351,861.01 Kwh, the amount of energy is needed due to the building has the biggest area and passenger arrival and departure activities centered in this building. The CO_2 emissions is influenced by the building materials and height of the buildings at Kulon Progo airport, which is calculated based on the amount of CO_2 in the building area per square meter. The existing building at Kulon Progo airport has different CO_2 emissions values, the highest CO_2 emissions produced by ATC second floor building with CO_2 level is 2,679.77 $kgCO_2/m^2$

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