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Airport Management: Sustainable Projects to Sustainable Operations

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Abstract: Airports are big campuses, divided into the groups of buildings, separated groups of buildings which are achieving lots of functions, both integrated and standalone. These campuses are being use by the demands of the passengers. They should understand airport usage statistics andrecorded results of actions as a vital index of how the local trade, economy, production, and services developed and how this trend will develop. Airports plan by the operational conditions, designed to smooth operations when transition and build. A sustainable airport management can achieve by knowing of the key factors during the planning, designing, building, and operating in life cycle phases. This paper describes factors to focus for planning, projecting, and operating of the sustainable airport as a wide point of view; also studies the sustainability practices to guide the airport managerial staff in a holistic approach. All environmental investments will return as a profit and sustain economic stability of the airport.

Keywords: Airport Management, Sustainability, Sustainable Airport Design, Sustainable Airport Project, Sustainable Airport Operations

I. Introduction

The concept of "Sustainability" is not just only for the construction or operational companies, but it is important for all over the world precisely. Connecting the airports through the airline bridges together have increased environmental effects for all the world. Beside those environmental negative effects, there have improved problems caused by operational, social, and economical new problems to resolve. Considering the population around the airport campuses, airport managers must think twice, and the end minded, and levels of the management are the main responsible for the environmental and financial effects of their decisions. Sustainable decisions caring with the environment and financially strength development plans are the main pillars of the sustainability. Sustainability advice adds value to the Airport Construction works and the Airport Operations.

The main idea for the Airport Management is minimum harmless decisions to sustain mentioned economical entities for lasting long through the years. Airports must maintain their profitability to ensure this idea. This idea can achievable through sustainable projects which must start with the planning and designing phase. There should be a connection between the airport projects and the operations on sustainability. They define this as overall sustainability.

Overall sustainability for airports is necessary for end minded operations. Business needs define the airport project specifications and capacity needs carry the design on bigger numbers. However, bigger numbers may not be just the bigger designs. Bigger designs are affecting the doubles or triples the problem counts and adding new approaches to the solutions. Sustainability advises, and case studies are important if airports are looking for seamless sustainable operations.

It has shown itself when scanning and researching through the resources "Airport Cooperative Research Program" (ACRP) has a proven knowledge regarding what the airports can do on sustainability (Martin, 2009). They have listed out the most important items on airport sustainability in their 18th resolution. This resolution can be understood as a master starting guide. The book called "Planning and Design of the Airports" have focused on the planning of the airport and categorized this planning tasks into financial and environmental titles. This study has mainly defended the importance of the financial strategy of the airports; besides how the project must plan and realize. In an addition, operational issues have investigated on environmental, ecological, and social effects subject. This study has focused the resolution of social benefits of the airport project on a city development.

There is another resource on designing of the airport and the engineering or the airport as a book named "Airport Engineering" (Ashford, 2011) which is focusing on capacity planning to focuses on air traffic prediction. This book underlines the importance for the aviation organizations statistics and reports to predict

future figures. Aviation organizations are using the passenger seat for kilometers, airline movements per destination, passenger count (pax) for specific destination figures to measure up the industry. Green-field air projects are presumably hard to use these figures, but airport extension projects and development projects must find those figures to better decisions. For green-field development projects, airports must use the below criteria to decide,

- Expert judgment,
- Ratios and national statistics,
- Trend analysis,
- Market share reports,
- Economic development models.

Some integrated resolutions can develop by the below assessments,

- High season assessment,
- Route selection models,
- Visual model aided assessment.

Sustainability has considered of a cycle to develop by innovation and redesigning activities for reduce environmental effects and improving the financial stability to reducing costs and improving the profit for the facilities. Following sections will resolve the basics for the sustainable operations delivered from the sustainable projects. Operational sustainability is a result of the environmental sustainability investments and environmental sustainability actions are known by the sustainability practices. Those practices will help airport managerial staff to evaluate as a guideline to manage the airport.

II. Prerequisites for the Sustainable Airports

Sustainability may define differently from different institutions and companies. Every department has their own measurement and understanding for sustainability. Financial and commercial departments understand financial stability from sustainability. However, technical departments are thinking the environmentally. Project teams are focusing to clear and adapted working techniques to deliver the project package, but operational teams must consider the conditions through the decades. Airport holistic approach has defined as to managing an airport to ensure the integrity of the economic viability, operational efficiency, natural resource conservation, and social responsibility of the airport by the 'Airport Council International' (ACI) (ACI, 2005). Besides this definition 'Airport Cooperative Research Program' has categorize the "sustainability" under three subjects as listed below (ACRP, Airport Sustainability Practices, 2008).

- Environmental practices commonly in place at airports include measuring and monitoring water conservation, water quality, climate change, air quality, land use, biodiversity, environmentally sustainable materials, waste, noise and aesthetics, energy, and green buildings.
- Economic sustainability practices commonly in place at airports include local hiring and purchasing, contributing to the community, quantifying the value of sustainability practices, contributing to research and development, and incentivizing sustainable behavior.
- Social concerns at airports include public awareness and education, stakeholder relationships, employee practices and procedures, sustainable transportation, easing road congestion, accessibility, local culture and heritage, indoor environmental quality, employee well-being, and passenger well-being.

For a summary, for an environmentally sustainable airport, some criteria that can understand a holistic view of an airport's progress towards sustainability. A first criterion is the reporting for the environmentally sustainable airports. How the reporting should consist to understand is this a sustainability. Which can be energy use, waste management and natural resource use like water? Other criteria are we going to consider this usage by quantitative or qualitative? Are there any stages to track the statuses like how to plan, design, implement and measure the amount of the sustainable airports? Those answers are the basic keys areas for the airport management.

Considering for all above prerequisites for the sustainable airports, below items can be the master criteria for the sustainable airports.

- Reducing the energy usage,
- Reducing the effects to air and water quality and reducing the pollution,
- Waste management and reducing the waste,
- Reducing to use natural resources,
- Development for the construction materials and the techniques,
- Development for the constructional health and safety precautions,
- Securing airport operations from airport construction activities,
- Reducing the noise and pollution effects for the airport campus neighborhood,
- Reducing all the costs down,

Following sub sections will describe the Sustainable Projects and Transition activities to handle the sustainable operations.

2.1 Sustainable Projects

Most important thing for the airport construction projects is the control. Sustainability has steered by the controlling systems, like reporting and measuring, and these tools must design by planning phase. Planning should address what the airport project will be. Planning phase ensures all the team members to end minded. Sustainable projects become manageable when the planning defines the teams, target and what to do.
Next stage for the sustainable airport project is design. Design defines which material to use and how those materials integrated to become an airport. Because, locally bought, environmentally neutral, long lasting materials are the main input for the sustainable airport project. Management for the project must understand and use the Sustainable Airport Practices from ACRP (ACRP, Construction Practices, Report 42, 2011). These practices have categorized like below.

- Roles and responsibilities,
- Construction methods,
- Logistics,
- Equipment,
- Transportation,
- Material and equipment reuse,
- Sustainable materials.

Above criteria have filtered as below to subjects,

- Sustainability targets,
- Planning,
- Procurement competencies,
- Training and human resources,
- Meetings,
- Marketing and public relations,
- Health and safety,
- Competency and performance management,

2.2 Transition to the Operations

Airport projects are managing under FIDIC contracts (Fédération InternationaleDesIngénieurs- Conseils), (FIDIC, 2007). These projects have several types of the contracts as described below.

- Green book, short-term contract,
- Red book, contract for following employers' requirements,
- Yellow book, contract for electrical and mechanical works starting from design to build,
- Orange book, turnkey design and built contracts,
- Silver book, turnkey, engineering, procurement, and built contract,

- DBO Project, design built and operate contract,

All these contracts have testing, commissioning and transition phases connected to the training of the human resources. They call this as 'Operational Readiness and Transfer' (ORAT) in airport industry. ORAT has focuses on the operational needs to process passenger, baggage, security, and stakeholder activities. Ensures the trainings are effective and prompt for the stakeholder processes. ORAT tests are shaping around the key strategic plans to measure the readiness of the transport plans, master plans, environmental assessments, business plans, supervision of the human resources, management of the processes, and operational safety. Airport management is to be ensuring it matches those plans with a sustainable airport operation.

III. Sustainable Airport Concept and Operations

Sustainable airports provide development, transformation and improvement. Sustainable airport also an aid to the reaching target. Below listed items are the airport sustainability key measures.

- Water use efficiency,
- Energy and atmosphere,
- Materials and resources,
- Interior air quality,
- Innovations on operations and maintenance,
- Education and training,
- Measurement and evaluation.

Airport sustainability can achievable by the focused management. Developing the gray water plumbing systems and water air mixing adapters in sink armatures will help you hit the bulls-eye on target. If the airport management focuses of the sustainable airport practices airport become economically and environmentally sustainable. Sustainable Aviation Guidance Alliance (SAGA) has founded to create a knowledge base for sustainability practices. Those practices have categorized under eight domains as below.

- Energy and climate,
- Ground transportation,
- Economic performance,
- Design and materials,
- Engagement and leadership,
- Water and waste,
- Natural resources,
- Human well-being.

Designing the spaces in airports to achieve a direct line of sight and vision glazing for building occupants has a marginal cost below than 5 000 US dollars. But this capital cost payback time is usually lower than 2 years and there won't be any big impact to operational and maintenance costs. However, there will be a huge positive affect to human wellbeing and energy use in the airport buildings.

Airport sustainability management is mostly relying on sustainable projects. Standard project approach was only considering about the project life cycle and focuses to a successful delivery. Successful delivery means for project people is completing the pieces of the jigsaw puzzle together to visualize the end product. However, sustainability needs for the corporations, developed society and the perception of the globalized people has transformed the project understanding. The projects necessities have changed the way of working. Figure 1 is showing the standard way of project life cycle which hasa planning, designing, building, and transferring phases. Despite of the former project understanding environmentally, and economically stabilized, sustainable airports must think about the wider effects of every design decision. Figure 2 shows the sustainability approach for a life cycle for the entities which involves the project life cycle.

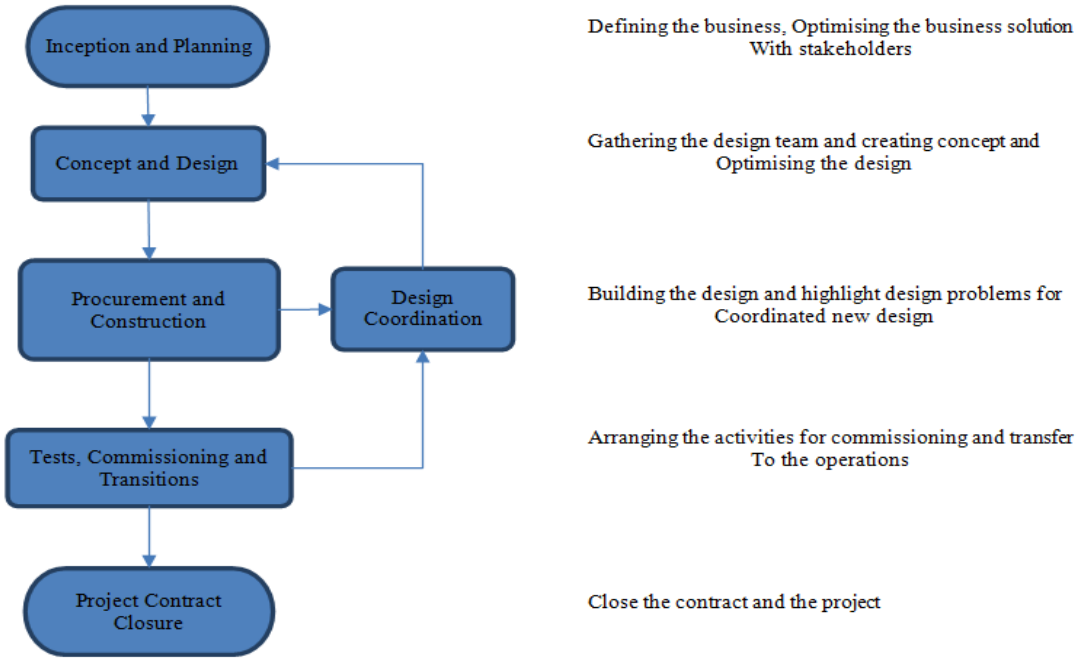


Figure1: Classicaland Practical ConstructionApproach

'Airports Going Green' (AGG) is measuring the airports how much sustainable they are. This arrangement is targeting an overall transformation which is helping the aviation industry cleaner. AGG is using 'Leadership in Energy and Environmental Design' LEED methods to measure how the airport green. They believe zero emissions in airports are not a dream anymore. LEED iscalculating the key environmental parameters to make the airports overall score meaningful by Silver, Gold, and Platinum awards so AGG does in green leavessymbols.

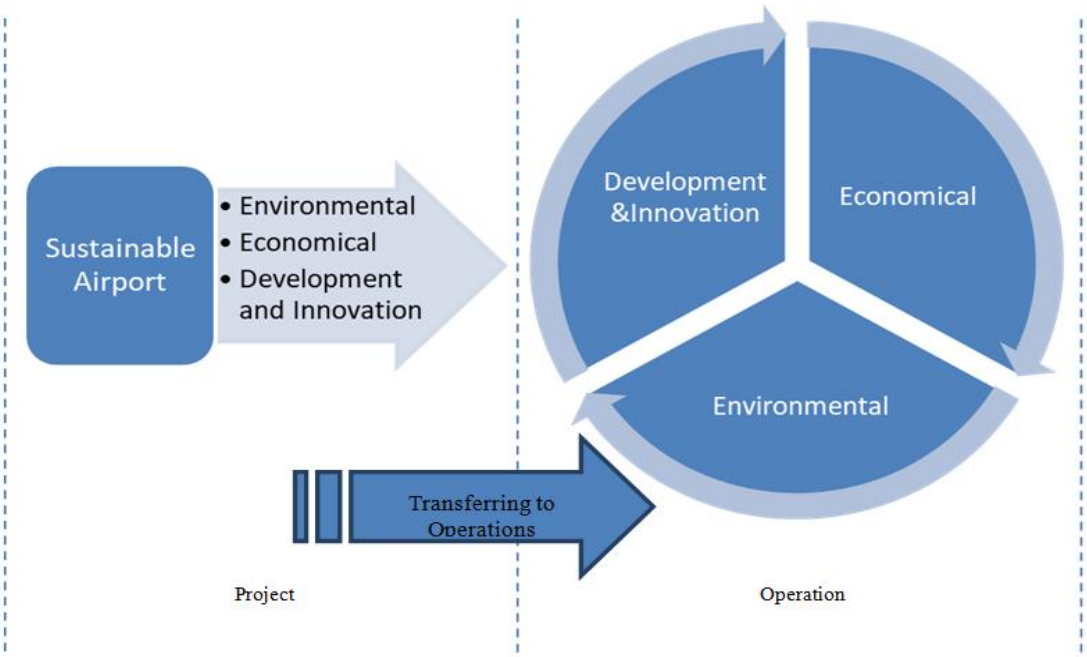


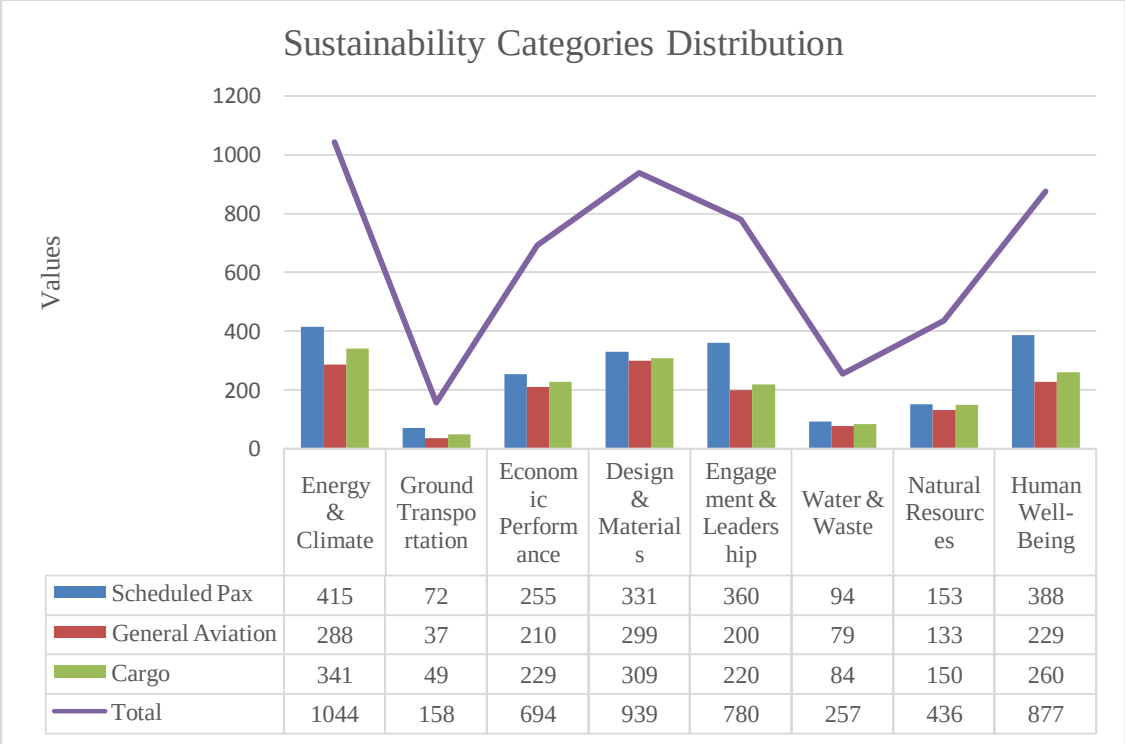
Figure2: SustainableAirportsManagement

3.1 Assessing the Sustainability Categories for Airport Management

SAGA is collecting sustainability practices for airport management people to let related area and category to guide their companies for sustainable business and environment. Methodology for this assessment is using the categories defined in SAGA to express and analysesustainability practices. All practices have their own categories listed in Section 3. Those categories are decisive selections for the proposed practice. Each practice can have one category or more related with the activities described under this practice.
Furthermore, system itself and the practice owner assigns a priority index for each practice between 1 to 100. This value represents the importance and the severity of the proposed practice. Management people can focus their own necessities considering this priority index. Priority index become important while calculating the categories sum in the effect of multiplying. Each category will have their index value for related practice. Thus, this value becomes the importance of each category on the selected airport characteristics.
Airports are big campuses and consists of lots of buildings inside. That buildings can be different functions for the aviation perspective. Most important three functions can be listed as below.

- Scheduled passenger traffic,
- General aviation traffic,
- Cargo traffic.

Figure 3 is showing the distribution of categories for the airport traffic functions. Distributed totals are the indicators for importance of the categories. Most important three categories are 'Energy&Climate', 'Design & Materials', and 'Human Well-Being'. Which is followed by 'Economic Performance' and 'Engagement and Leadership'. The indexes are showing another hidden value which all categories are supporting 'Economic Performance' category in anyway.
Below figures have calculated from 968 sustainability practices. All practices have marked as eight categories and the airport traffic functions demonstrated as 'Scheduled pax', 'General Aviation', and 'Cargo'. Those figures are defining the importance for the sustainability domain (SAGA, Practices, 2015).

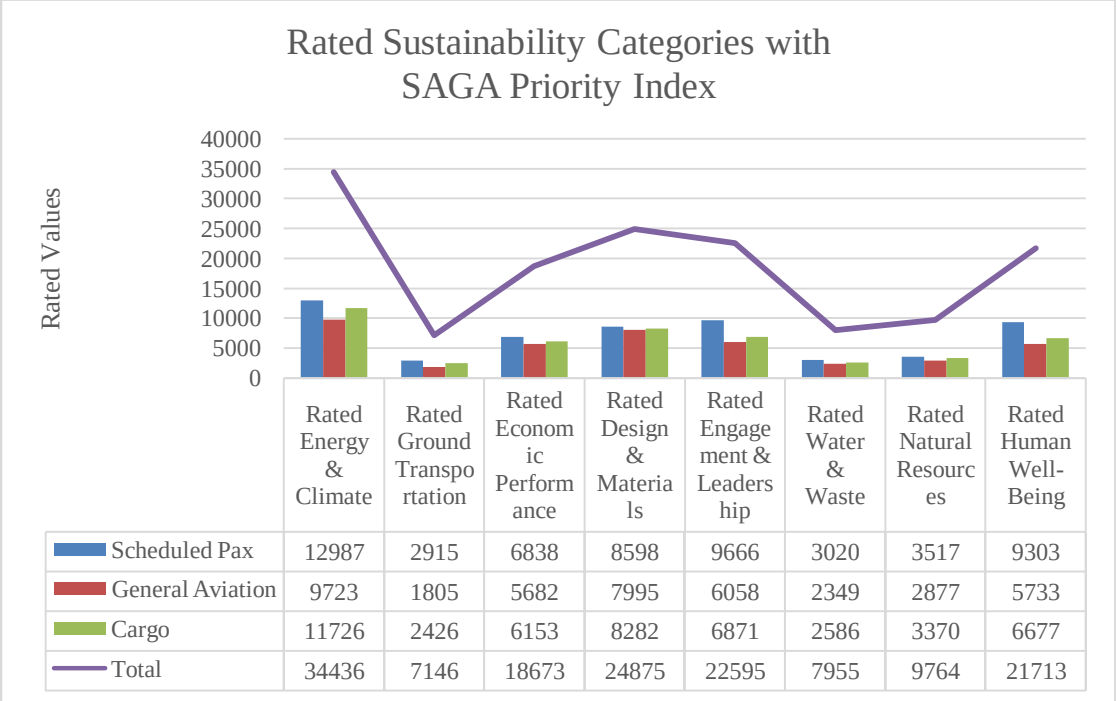


	Energy & Climate	Ground Transportation	Economic Performance	Design & Materials	Engagement & Leadership	Water & Waste	Natural Resources	Human Well-Being
Scheduled Pax	415	72	255	331	360	94	153	388
General Aviation	288	37	210	299	200	79	133	229
Cargo	341	49	229	309	220	84	150	260
Total	1044	158	694	939	780	257	436	877

Figure 3: Sustainability categories distribution in sustainability practices

Figure 4 is showing the rated values derivate from SAGA Priority Index created by the practice owner and the system. Prioritization Index is the result of the weight of the practice details. The practice details are fixed for each practice for example the capital cost or operations and maintenanceexpenditures. The weighted index

reflects the authors preferences as represents itself on the airport function profile. On the resulted index value those practices show its importance by the sustainability category.
Mentioned practices are the guides for airport management staff and focus points. A technical manager of the airport and the financial department will focus different areas of the sustainability practices to focus on their economic and environmental stability. It has shown as the total and functional based values in Figure 4 that, most important category is 'Energy & Climate' category. Energy is the most expensive and limited value in the world and conservation of the energy is becoming more and more important in aviation industry.



	Rated Energy & Climate	Rated Ground Transportation	Rated Economic Performance	Rated Design & Materials	Rated Engagement & Leadership	Rated Water & Waste	Rated Natural Resources	Rated Human Well-Being
Scheduled Pax	12987	2915	6838	8598	9666	3020	3517	9303
General Aviation	9723	1805	5682	7995	6058	2349	2877	5733
Cargo	11726	2426	6153	8282	6871	2586	3370	6677
Total	34436	7146	18673	24875	22595	7955	9764	21713

Figure 4: Rated values for the categories, products of sustainability index.

Another 3 important areas are shown as 'Design & Material', 'Engagement & Leadership', and 'Human Well-Being' as per the calculation represented above. Those values are the key management focus points to let airport more manageable. On the other hand, energy-based sustainability is not the only key for aviation industry. Aviation industry has two important pillars; the airports and the airlines. Airlines are the biggest energy consumers around the world comparing with the airports. For this reason, the energy consumptionshould be evaluated for the airline point of view in the airport area (Dalkiran, 2017). Aircrafts are also responsible from the environmental effects in the airport campuses.

3.2 Airlines Effect for The Environmental Sustainability In Airports

ICAO agrees about aircrafts are affecting the local environment below 3000 feet (ICAO, Air Quality Manual, 2011). It has stated as, *"8.1.4 Note that the impact of an aircraft's emissions plume, at or above 3 000 ft, on NO_2 ground-level concentrations is very small even in a very conservative analysisand 1 000 ft is the typical limiting altitude for groundlevel NO_2 concerns"*. So the airline based energy and climateeffects are on its place.
IATA has stated that airline traffic will be doubled in in 2036 comparing with 2016 in 20 years. That is creating big concern for the environmental effects (IATA, Annual Review 2016) happening as an air pollution. These effects are categorized under the energy and climate domain in SAGA practices (SAGA, 2015).
Table 1 shows about how the passenger and airline movement developed through the four years consequently starting from 2010 in Thailand airports as an example. All aircraft movements have increased minimum 9% year to year and the average of 13% which the passenger counts have increased minimum 8% and the average of 15% in same time frame. This shows very sustainable economic growth has achieved throughout the years. It is also pointing another aspect of this growth as low-cost carrier. Low-cost carrier (LLC) has grown up minimum 15% and the passengers who are choosing the LLC airlines has grown up in same ratio. But it grows up in average for the LLC airline movement is 20% while the pax grows up 24%. This defines the airports of Thailand has a bigger sustainability figures on passenger development which will affect the airline new route development and movement.

Table 1: Aircraft and Passenger development of Thailand Airports

	Aircraft (in thousands)			**Passengers (in Millions)**	
Year	Allaircrafts	LCCs	**Year**	AllPax	LLCPax
2010	385.77	108.12	**2010**	57.2	13.99
2011	441.44	132.73	**2011**	66.3	17.65
2012	480.34	152.8	**2012**	71.52	20.34
2013	559.42	184.99	**2013**	86.13	26.61

Moving forward to IATA future expectations and the figures in Table1 is pointing to the airline movements are improving gradually. This gradual improvement will increase environmental effects in the airports too. Scientific discussions and research and development should focus on this mentioned growth to develop more sustainability practices.

IV. Discussion, limitation and conclusion

Unlike many obstacles for the management staff in aviation sustainability practices are helpful. This paper has focused the importance of sustainability and holistic specification of the environmental and economic point of view. Airport sustainability categories evaluated under eight domains has shown that that 'Energy and climate' is the most important aspect of the airport management. A conceptual framework for the sustainability practices and evaluation processes for the airports are helpful to focus management problems for the managers.

It has shown that three out of eight sustainability categorizations, 'Ground transportation', 'Water and waste', and 'Natural resources' are the tailing categories. However, following to all practices will help the managerial staff to guide through their cost, social, and environmental targets. It is a matter of organization arrangement and lost-profitability analysis to following those sustainability targets. Small airports are the significant developer for these practices to easier re-organizations for the sustainability challenges.

Modern and technological approaches for the problems are always helping managers to record and assess their actions in time. The airport managers can develop sustainability practices by recording and assessing the actions and tasks through the improvement processes. Consequently, the calculation method on the sustainability practices has shown that mentioned guidelines are key performance indicators of an airport improvement.

This study has limitations on the data provided by the SAGA and practice authors respected their inputs are reflecting their precise approaches for the improvement. Aviation industry believes the power of importance and the power of the engineering. Evaluation for the experiences will be the most important value for safety and development. Operational sustainability is a result of the environmental sustainability investments and environmental sustainability actions are known by the sustainability practices.

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