

Design and Development of the Puerto Princesa Airport Passenger Terminal

Jocelyn Buluran ^a, Geoffrey L. CUETO^b, Francis Aldrine A. UY^c, Anna Katherine A. DE TORRES ^d, Kunjing LI ^e, Vina Korina M. SOLIDUM ^f

^{a,b,c,d,e,f} *Graduate School of Civil Environmental and Geological Engineering, Mapua Institute of Technology, Intramuros, Manila, Philippines*

^a *E-mail Address: jmsalama_eid@yahoo.com*

^b *Email Address: faauy@mapua.edu.ph*

^c *Email Address: geoffrey_cueto@yahoo.com*

Abstract: Airports are one of the main gateways of both passenger and goods to and from a country. The Puerto Princesa Airport, an airport serving the general area of Puerto Princesa City, ranks 7th in the country in terms of passenger traffic. Dubbed as the Eco-Tourism Center of the Country, the potential increase in air travel demand is probable most especially since two of UNESCO World Heritage sites reside in the province. This study aims to forecast future passenger movement of the passenger terminal of the airport and provide the structural plan for the single storey passenger terminal for the proposed improvement of the Puerto Princesa Airport.

Keywords: Airport, Puerto Princesa, Passenger Traffic, Air Travel Demand

1. INTRODUCTION

An airport is a station that consists of buildings and airfields used to house and provide runways for airplanes. Airports are used as the main gateway to and from a country. It consists of a runway for a plane to take off and land, control towers and hangars, and passenger terminals where passengers transfer between ground transportation and allows them to board and disembark from an aircraft.

In the Philippines, airports come in a range of shapes and sizes, and while some are used for international flights, others cater more to interisland travel. Most travelers first arrive in the country through the Ninoy Aquino International Airport (NAIA), the main international gateway in the country. From NAIA, travelers can catch another flight to one of the smaller airports in the country. One of these smaller airports is the Puerto Princesa Airport.

The Puerto Princesa International Airport is an airport serving the general area of Puerto Princesa City, which is located in the province of Palawan in the Philippines. The airport is the main gateway to the Puerto Princesa Underground River, a *UNESCO World Heritage site* and one of the *New Seven Wonders of Nature*. Recently, President Noynoy Aquino intended to make the airport one of the primary gateways of the Philippines aside from Clark International Airport and Ninoy Aquino International Airport.

According to the study "*Intermodal Transport Development Project (2006)*", the forecasted passenger movement as of 2012 is 369,792 pax. but the actual volume of passenger movement for the same year is 1,306,524 pax., showing 403% difference. But with the updated ITDP (2011) forecast, considering the 'with project' scenario, 946,493 passenger movements were forecasted. With the numbers stated above, the tourist resources that can be met with the existing airport are stunted compared with the potential tourist resource that can

be met with the proposed project.

To address the problem, this study aims to provide the structural design for the proposed one-storey passenger terminal of the Puerto Princesa Domestic and International Airport. The new passenger terminal shall meet the projected increase in air travel passenger demand and with consideration to passenger convenience, operation efficiency and arrangement of facilities; and, also keeping in mind the 25

General prosthetics of the airport to craft a better image for the province. Keeping in mind the image of the province, this study also aims to provide an innovative and sustainable design.

With this proposed project, it will cater the projected increase in air travel demand for the airport and will also improve the image of the province and indirectly the country. Using the concept of 'green building' most especially in the design aspect of the project, the project can increase the image of the province as a province who cares for the environment as it is most known for their natural beauty.

1.1 Problem Statement

Considering the current capacity of the existing airport and past passengers movements, as well as the existing airport will be developed due to its changing status from the current domestic to both domestic and international airport. Studies have been made to forecast the future passengers movements of the airport. According to the study "*International Transport Development Project (2006)*", the forecasted passenger movement as of 2012 is 369,792 pax. but the actual volume of passenger movement for the same year is 1,306,524 pax., showing 403% difference. But with the updated ITDP (2011) forecast, considering the 'with project' scenario, 946,493 passenger movements were forecasted.

Also according to Gerry Burts (2007), an online reviewer from sleepingairports.net, "*The terminal building is only for departing passengers but it's too small so passengers are queuing outside the terminal exposed to sunlight. But when I get inside the terminal building, I wish I'm outside...*"

Therefore, the existing airport constraints the full air travel demand potential of the province which can be translated into stunting the potential economic gains and business investments for the province of Palawan. Another problem for the existing airport terminal is its open and limited facilities leaving a bad impression to its passengers that can reflect on the city and province itself.

1.2 Project Objectives

This study aims at forecasting the passenger movements of the Puerto Princesa Airport for the target year 2020 and providing a sustainable and efficient structural design for the proposed one storey passenger terminal of the Puerto Princesa Domestic and International Airport. The new passenger terminal shall meet the projected increase in air travel passenger demand by the target year 2020 and with consideration to passenger convenience, operation efficiency and arrangement of facilities; also keeping in mind the general prosthetics of the airport to craft a better image for the province.

1.3 Design Norms Considered

To ensure the design integrity of the passenger terminal, the design must comply with both local and international standards. For the structural aspect of the design, the *National*

Structural Code of the Philippines, Volume 1, Buildings, Towers, and Other Vertical Structures, Sixth Edition 2011 and *National Building Code of the Philippines* will be the designer's guide for a consistent design.

Also, to ensure that the design of the proposed terminal building is environmental friendly to keep the natural beauty of the surrounding areas, the design shall comply with *Department of Environment and Natural Resources (DENR) regulations and the Environment Compliance Certificate (ECC) No. 0210-757-215 (Dec. 15, 2003)*.

The design shall make use of the most economical and conservative design without affecting the structural integrity and general prosthetics of the building. Running in parallel with the province's love for the environment, the designers shall provide innovative and sustainable designs on par with the raising trend nowadays.

1.4 Major and Minor Areas of Civil Engineering

The primary objective of this study is to design a one-storey passenger terminal building to accommodate the projected air travel demand of the Puerto Princesa Airport, therefore the major area of civil engineering being considered is Transportation Engineering and one minor area is Structural Engineering.

Since one objective of this study is to design a sustainable and environmental friendly passenger terminal building in consideration with the province's image known for its natural beauty, another area of civil engineering being considered is Environmental Engineering.

1.5 The Project Beneficiary

The main beneficiary of this study is the Department of Transportation and Communications (DOTC). The project manager of the Puerto Princesa Airport Development Plan, Engr. Gill Pamatmat, therein is the main beneficiary representing DOTC.

Another beneficiary is the provincial government of Palawan as it will affect its economy greatly. With the probable influx of tourist resource, the potential economic growth for the province of Palawan can greatly increase. Moreover, the development of the Puerto Princesa Airport is expected to revitalize the transport and trade linkages under the Brunei Darussalam, Indonesia, Malaysia, and the Philippines-East ASEAN Growth Area (BIMP-EAGA).

The indirect beneficiary of the project is the passengers using the current facilities of the passenger terminal that will enable them a comfortable and convenient use of the proposed facilities.

1.6 The Innovative Approach

With the recent software developments in the field of architecture and engineering, the process of drawing the technical plans and designing the structural members of the building will be more convenient. Using the software *AutoCAD* for 2D modeling of the technical plans, *Google SketchUp* for the 3D modeling of the proposed building and *ETABS* for the structural design and analysis, the time it usually takes in designing a building can be cut in half.

1.7 The Research Component

Since the main problem of the project lies with the air travel demand of the Puerto Princesa Airport, the study aims to research on past studies done regarding past, present and future passenger movements forecasted. With the help of the beneficiary, the researchers obtained

the *Updated Airport Feasibility Study (2011)*, the latest *Conceptual Plan Reports and Performance Specification and Parameters Report (March 2013)* the Puerto Princesa Development Project.

The researchers also aim to study and incorporate the concept of a ‘green building’ to the project.

1.8 The Design Component

The structural design of the single storey passenger terminal of the Puerto Princesa Airport will be based on the architectural plans, conceptual plan reports, and performance specifications and parameters report provided by the beneficiary. The architectural plans will be subjected to change as it was based on past studies done by contractual agencies hired by the beneficiary. The main basis of the design however is the *Conceptual Plan Report (March 2013)* and *Performance Specifications and Parameters Report (March 2013)*, where in past studies have been compiled and updated to meet the current parameters of the study. These reports also contain the general concept of the proposed project. The structure must be designed in such a way that future expansion is possible with a new target year of 2040 in mind.

The design shall include basic airport utilities, passenger convenience facilities, part of commercial businesses such as duty free, concession, shops, and so on. It also includes minimum facility areas of airlines, resident agencies, etc. which are directly related to passengers and passenger handling activities.

1.9 Sustainable Development Component

Sustainability is a holistic approach to managing an airport so as to ensure the integrity of the economic viability, operational efficiency, natural resource conservation and social responsibility (EONS) of the airport (ACI definition developed by the airports) (OAFAA, 2013).

Known as the “*Philippines’ Cleanest and Greenest City*”, it is imperative for the researchers to design a sustainable and environmental friendly passenger building. The researchers shall provide sustainable designs that maximize the use of natural light and solar paneling and a sustainable waste management system. Keeping in mind the importance of public transportation, the researchers will fully integrate easy access to local public transportation to reduce carbon emissions.

2. REVIEW OF RELATED LITERATURE

In order to promote a more consistent and balanced economic development for the country, the Philippine government drew up major strategies to improve the people’s access to economic opportunities throughout the country. By expanding the present capacity of the existing airport, as well as to enhance the airport’s aviation operation, service, security, and safety standards by upgrading the airport’s facilities and equipment to comply with the International Civil Aviation Organization (ICAO) standards, the projected increase in air passenger and cargo travel demand will be met.

Moreover, the improvement and upgrades of the Puerto Princesa Airport is expected to revitalize the transport and trade linkages under the Brunei Darussalam, Indonesia, Malaysia, and the Philippines-East ASEAN Growth Area (BIMP-EAGA) (Lee, 2013).

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2.1 Air Traffic Demand

2.1.1 Annual Domestic Passenger Movement

According to the updated Intermodal Transport Development Project (2011) study, a comparison of the projected annual passenger movements that were arrived at under the previous studies presented on *Table 4.3.1*. As shown therein, the annual passenger movements projected under the TADP and ITDP studies are significantly different from the actual figures.

Table 4.1 Comparison of Annual Domestic Passenger Movements

Year	Actuals		TADP Forecast (2002)		ITDP Forecast (2006)		Updated ITDP Forecast (2011)	
	Pax Mov'ts	5-Yr. Growth Rate	Pax Mov'ts	5-Yr. Growth Rate	Pax Mov'ts	5-Yr. Growth Rate	Pax Mov'ts	5-Yr. Growth Rate
1995	146,795							
2000	208,714	42.2%						
2005	267,868	28.3%	243,000					
2010	762,127	184.5%	297,000	22.2%	337,289			
2011	989,762	29.9%	310,500	22.7%	353,541	24.1%	827,843	46.7%
2012	1,306,524	32.0%	324,000		369,792		900,399	
2015			364,500		418,547		1,118,067	
2020			432,000	18.5%	530,643	26.8%	1,493,222	33.6%
2025			512,000	18.5%	681,568	28.4%	1,904,900	27.6%
2030							2,348,586	23.3%
2035							2,817,726	20.0%
2040							3,303,739	17.2%

Note: Domestic excluding GA and Military

Table 4.1 shows that the actual volume of annual passenger movements for is 1,306,524 pax. On the other hand, the TADP forecasts 324,000 pax while the 2006 ITDP forecasts 369,792 pax, showing a difference of 352% ~ 403%.

Meanwhile, the forecasts made under the Updated ITDP (2011) are noted to be closer to the actual figures. The result of review of the Updated ITDP forecasts shows substantial differences when existing passenger demand forecasts and passenger service results were compared. The reason for this is that the number of air passengers at Puerto Princesa Airport exhibited a rapid increase since 2005.

2.1.2 Annual International Passenger Movement

Table 4.2 Forecasted International Passenger Movements

The annual international passenger movement forecasted on the ITDP (JICA, 2006) are presented on Table 4.2.

Year	International
2011	39,901
2012	42,252
2013	44,604
2014	46,955
2015	49,307
2016	52,395
2017	55,484
2018	58,572
2019	61,661
2020	64,749
2025	85,026
2030	111,653
2040	192,531

The proposed development is expected to address airport security, safety, operation, and capacity constraints so that the full air travel demand potential (domestic and international) can be met and be translated into the actual growth of air passenger and aircraft movements as per the unconstrained forecasts. Hence, the appropriate “With Project” scenario forecasts are the updated 2011 forecasts shown on **Table 10.3.3**. The table’s elements are broken down into international, scheduled domestic and general aviation plus military passengers. It can be noted that the previous international passenger forecast until 2025 (JICA, 2006) was used and projected using the same annual growth rate (Updated ITDP, 2011).

2.1.3 Actual Data on Domestic Passengers

The following data were based on the figures contained in the “*The Master Plan Study on the Strategy for the Improvement of National Airports in the Republic of the Philippines*” conducted in 2006 by Aviation Systems Consultants (ASCO) for the Department of Transportation and Communications (DOTC) and Japan International Cooperation Agency (JICA). The most recent data from 2005 to 2010 were based on the figures contained in the “*Puerto Princesa Airport - the Updated Feasibility Study*” conducted in 2011.

Table 4.3 Actual Domestic Passenger Movement

Year	No. of Passenger	Annual Growth	Comments
1995	146,795		
1996	193,330	31.7%	
1997	230,054	19.0%	
1998	159,106	-30.8%	Stoppage of Philippine Airlines (PAL Services)
1999	199,086	25.1%	
2000	208,714	4.8%	
2001	188,403	-9.7%	Dos Palmas kidnapping incident
2002	147,000	-22.0%	Dos Palmas kidnapping incident
2003	194,176	32.1%	
2004	267,507	37.8%	
2005	267,868	0.1%	
2006	294,945	10.1%	
2007	377,124	27.9%	
2008	477,673	26.7%	
2009	578,613	21.1%	
2010	762,127	31.7%	
2011	989,762	29.9%	
2012	1,306,524	32.0%	

According to the data above, it shows the trend in the air passenger movements at Puerto Princesa is erratic, although there has been a net increase in annual passengers of 6.2% over the period 1995 to 2005. Between 1995 and 1997 the annual growth was 28%. The growth trend dropped in 1998, with passenger traffic falling 30% from the previous year. The negative growth rate was a result of disruptions in the operations of Philippine Airlines (PAL) that was triggered by a series of protest held by PAL employees against management. The subsequent resumption of PAL's operations at the airport caused a rebound in passenger growth in 1999 up to 2000 with traffic growing by an average annual rate of 15.6% during the period.

2.1.4 Actual Data on International Passengers

According to the "Conceptual Report", there are no official international traffic records before 2005 but interviews conducted with airport management confirmed that there have been occasional international charter operations in Puerto Princesa with varying aircraft type.

In July 2004, a special commercial service between Puerto Princesa and Seoul was pioneered by Philippine Airlines opening a Philippine gateway for Korean tourists. PAL proposed a twice weekly service with an A320 aircraft. Also, Korean Airlines serviced the occasional route four times connecting Incheon and Puerto Princesa in 2012.

2.2 Aircraft Movements

The result of the aircraft movement projection between the Updated ITDP (2011) and the Review (2013) show, that the latter yielded a slightly higher volume projection. The projections arrived at in the Review (2013) will be applied in this task.

Table 4.4 Comparison of Annual Aircraft Movements

Year	Updated ITDP (2011)				Review (2013)			
	Int'l	Sch. Dom.	GA+Mil.	Total	Int'l	Sch. Dom.	GA+Mil.	Total
2015	820	12,355	1,726	14,901	158	9,719	3,206	13,083
2020	1,078	14,676	2,437	18,191	208	13,884	4,526	18,617
2025	1,414	17,031	3,249	21,694	273	18,450	6,034	24,758
2030	1,858	19,566	4,163	25,587	358	23,375	7,731	31,465
2035	2,908	22,246	5,077	30,231	471	28,581	9,429	38,480
2040	3,204	25,022	6,092	34,318	618	33,976	11,314	45,908

The preceding table indicating the results arrived at under the Review (2013) shows that, by 2020 1-way peak hour traffic for international operation will reach 0.54 flights and for domestic operations will register 3.25 flights.

2.3 Airlines and Aircraft Types

The major airlines that operate at Puerto Princesa Airport make use of various types of aircrafts for their scheduled flights to and from Puerto Princesa. The respective seating capacities of these aircrafts and the number of flights are shown on Table 4.5.

Table 4.5 Air Traffic Movements by Airline with Capacity (As of July 2011)

Airline Operator	Aircraft Type	Mvts. per Day	Mvts. per Week	Route	Seating Capacity
Philippine Airlines	A330	2	14	MNL-PPS-MNL	250
	A320 / A319	2	14	MNL-PPS-MNL	150
Cebu Pacific	A320 / A319	6	42	MNL-PPS-MNL	150
	A320 / A319	2	14	CEB-PPS-CEB	150
	A320 / A320	4	28	MNL-PPS-MNL	118

Air Philippines	Bombadier (DH-4)	(Tue & Sun)	4	BUS-PPA-BUS	50
Zest Air	A320 / A319	4	28	MNL-PPS-MNL	150
TOTAL		20	144		

This weekly mix and number of aircraft produce a weekly seat capacity of 12,252 seats. If this seat capacity is compared with the annual passenger throughput of 762,127 in 2010, the average load factor would be about 62% for each airline.

The route profile for the Puerto Princesa Airport showing the frequency of flights per week per airline operation as of July 2011 is given on Table 4.6.

Table 4.6 Route Profile (As of July 2011)

ROUTE	FREQUENCY OF FLIGHT PER WEEK				
	PAL	AIR PHIL	CEBU PACIFIC	ZEST AIR	TOTAL
Manila-Puerto Princesa	14	14	21	14	63
Puerto Princesa-Manila	14	14	21	14	63
Cebu-Puerto Princesa	0	0	7	0	7
Puerto Princesa-Cebu	0	0	7	0	7
Busuanga-Puerto Princesa	0	2	0	0	2
Puerto Princesa-Busuanga	0	2	0	0	2
TOTAL MOVEMENTS	144				

2.4 Busy Hour and Stand Demand Forecasts

Another requirement to be carried by passenger terminal facilities is the calculation of the current and forecast passenger busy hour demand. Busy hour passenger demand is then converted into a peak hour stand demand by consideration of existing and projected aircraft mix profiles and apron occupancy times. Busy hour forecasts are particularly important in terms of checking the adequacy of proposed passenger terminal and aircraft parking requirements. Busy hour refers to the one hour during the day with the greatest number of movements.

2.5 Gate Allocation Chart

The Gate Allocation Chart is a plot of aircraft schedules to show each aircraft's arrival and departure time on a timeline. The figure below shows the 2011 aircraft schedules and a 15-minute "buffer" was included in the figure for maneuvering time in the vicinity of the gate and for off-schedule arrival/departure of the aircraft (Kim, 2013).

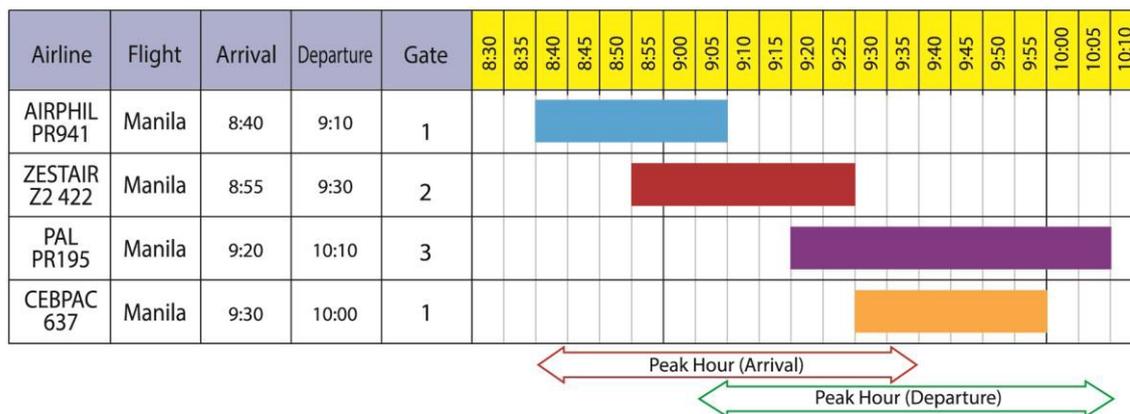


Figure 4.7 Gate Allocation Chart

2.6 Aircraft Stand

The table below is a comparison of the projected aircraft stand requirements arrived at under previous studies including the Conceptual Report (2013). The results of the said report shall be adopted which consists of 2 E class, 3 C class and 1 Layover (C class) aircraft stand requirement by 2020.

Table 4.8 Comparison of Aircraft Stands

Reference Code	ITDP	2020		2040	
		Updated ITDP (2011)	Review (2013)	Updated ITDP (2011)	Review (2013)
Domestic					
E	0	1	1	3	1
D	0	0	0	0	0
C	3	3	3	3	5
Regional Jet	2	0	0	0	0
Turbo Prop	1	1	0	1	0
Sub total	6	5	4	7	6
International					
E	1	1	1	1	2
D	0	0	0	0	0
C	0	0	0	0	0
Sub total	1	1	1	1	2
Layover / Stand off					
Assume 15%	1	1	1	1	2
Total	8	7	6	9	10

2.7 Passenger Terminal

In the Three Airport Development Plan (TADP) (2002), it suggested in building a new passenger terminal with consideration to passenger convenience and operation efficiency and arrangement of facilities. It also states that the aggregate area requirement to cover the facilities listed above is placed at 6,100 m², while the total area requirement for the entire terminal building including circulation and unallocated areas is computed at 7,500 m². Though, the updated ITDP (2011) places the total area requirement for the proposed terminal building at 9,800 m², while the loan agreement between DOTC and K-EXIM indicated a total terminal building area of 9,492 m². But, considering the target year of 2020, the total terminal building area is 12,435 m².

According to FAA standards, passenger terminal size is determined by the area required per peak hour passenger at the time of designing; 23.02m² per one-way passenger is required for domestic flights, and 37.26m² per one-way passenger is required for international flights. However, since Puerto Princesa Airport is relatively a small size airport, FAA standards need not necessarily apply. In this case, Philippine airport case standards can be adopted.

According to the Performance Specifications and Parameters Report (2013), the following are the building design concepts for the passenger terminal building:

- Concept in harmony with the natural landscape and Palawan's world heritage
- Eco-friendly and energy saving building design
- Check-in counter with business and public service concept atmosphere.
- Secure safety and security
- A local landmark that gives a good impression to domestic and international tourists
- Short and straight route movement flow of passengers and airport staff.
- Provide conveniences for the old and the infirm
- Design the structure with consideration for future expandability
- No office inside the passenger terminal not unless necessary

2.8 Solar Energy Technology

Solar cells are made of semiconductors and every type of semiconductor has a property called a band gap. The band gap defines the longest wavelength of light a semiconductor can absorb (it is transparent to longer wavelengths). It also fixes the maximum amount of energy that can be captured from photons of shorter wavelength. The result is that long-wavelength photons are lost and short-wave ones incompletely utilized (Economist.com, 2014).

"Sunlight is free, but that is no reason to waste it" as stated by economist.com. The latest technology nowadays converts sunlight into solar energy that can be used as electricity in homes, commercial establishments, etc. But the most common type of solar panel – the silicon solar cells – convert only a quarter of the light that falls on them. The silicon solar cells have the merit of being cheap, but manufacturing improvements have brought its price to a point where it is snapping at the heels of fossil fuels.

John Rogers, of the University of Illinois, devised solar cells wherein they convert 42.5% of sunlight which can be possibly increased to 50% efficiency. The secret is it is made up of four cells, stacked on top of another, unlike the silicon solar cells.

The new panels improvised by Dr. Rogers have aesthetic advantages as 99.9% not covered by stacks can be used for art. The panels appear black if seen from straight ahead which absorbs all the sunlight falling on them. But if viewed obliquely, their foci are on the other parts of the panel.

Since Palawan is plagued with power shortage which sometimes last up to 10 hours, a source of nonrenewable energy for the airport is ideal as Palaweños pay double for electricity – 12 pesos per kwh (kilowatts per hour) – compared to only 6 pesos in Metro Manila because Palawan is not connected to the national grid, power is produced by diesel plants. Furthermore, a micro-grid solar power plant generating 1.3 megawatts of clean renewable energy, the largest in the Philippines is proposed to be built in Palawan (Sison, 2014).

2.9 Waste Management System

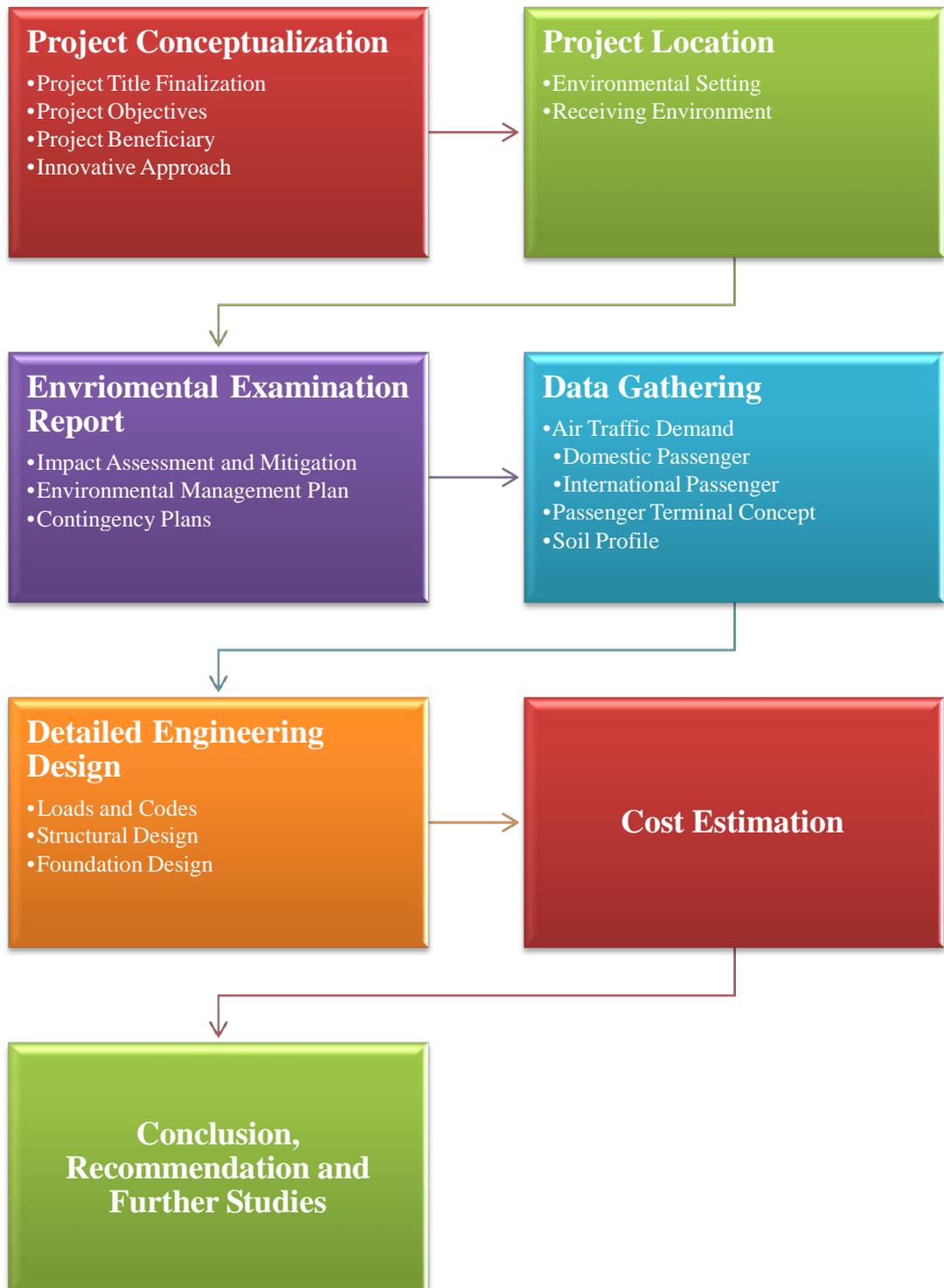
The passenger terminal of an airport has the highest concentration of people, which can translate into the biggest concentration of waste. The terminal building not only has the ticket counters and gates and office space and break rooms for airline and airport personnel but also restaurants, shops and restrooms that are frequented by passengers, families, and employees of airlines and airports.

According to OAFAA (2013), there are eight types of wastes from airports: (1) municipal solid waste, (2) construction and demolition waste, (3) green waste, (4) food waste, (5) deplaned waste, (6) lavatory waste, (7) spill cleanup and remediation waste, and (8) hazardous materials.

But in the terminal building, the types of wastes produced varies which includes food wastes, paper, plastic, aluminum cans, restaurant grease and oil, universal wastes (electronics, light bulbs, batteries), green waste (from lawn care), general trash and deplaned waste from aircraft; also, while constructing the passenger terminal different types of wastes will be produced like concrete, asphalt, building materials, wood, soil, construction equipment waste, and regular trash (OAFAA, 2013).

Therefore, a proper and sustainable waste management system is ideal although challenging as there are many factors that can be proven as an obstacle that can impede the success of this program.

3. METHODOLOGY



4. RESULTS AND DISCUSSION

The Puerto Princesa International Airport is the main airport serving the general area of Puerto Princesa City, which is located in the province of Palawan in the Philippines. Currently, the Department of Transportation and Communications (DOTC) has plans to renovate the airport to better serve the increasing passenger demand, both domestic and international. The plans have been in the books of the department for over a decade now with numerous studies regarding it, namely, Third Airports Development Project (COWI-NACO, 2002), Intermodal Transport Development Project (Louis Berger, 2006) and an updated version of ITDP (DOTC, 2011). But due to one reason or another, the renovation plans have been delayed for years.

As shown above, the increase of domestic passenger movements is dramatic as the 267,868 passenger movement from 2005 to 762,127 passenger movement on 2010 with a growth of 184.5%. The unpredictable increase of domestic passenger movement is also tough to forecast as evident with the past studies. On the Updated ITDP Forecast (2011) made by DOTC, it forecasted 900,399 pax movement but the actual pax movement is 1,306,524 with a difference of 36.8%. In the past ten years, according to the actual number of domestic passenger movement, the airport only experienced an increase in pax movement with an average growth of 24.94%. This dramatic increase can be attributed to the fact that the province of Palawan has an increasing reputation in the international scene.

While the international passenger movement has no official record of its traffic before 2005, there are occasional charter operations in Puerto Princesa. Most notably, *Philippine Airlines* initiated a special service between Puerto Princesa and Seoul. Also, *Korean Airlines* serviced an occasional flight between Puerto Princesa and Incheon. The data above that forecasted the international movements are from the Updated ITDP (2011), as the researchers have no basis to base their forecast on.

The major airlines that operate at Puerto Princesa Airport, namely *Philippine Airlines*, *Cebu Pacific*, *Air Philippines* and *Zest Air* use different types of aircraft with varying number of seats ranging from *Air Philippines*' Bombardier (DH-4) type of aircraft 50 seats to *Philippine Airlines*' A330 type 250 seats. It is important to note the seating capacity of the different aircraft currently operating at the airport to forecast the peak hour passenger. These aircrafts are making twenty (20) movements a day and 144 movements a week as of July 2011 making a seating capacity of 21,704 per week.

The Busy Hour refers to a one hour during the day with the greatest number of movements. The passenger busy hour demand is required to be forecasted for the calculation of the total area of the passenger terminal facilities and aircraft parking requirements. To determine the busy hour, the gate allocation chart is plotted. The gate allocation chart is a plot of aircraft schedules to show each aircraft's schedule. Currently, the peak hour for the arrival is from 8:40 am to 9:40 am while the departure peak hour is from 9:05 am to 10:05 am. Therefore, the overall peak/busy hour of the passenger terminal is from 9:05 am to 9:40 am.

5. CONCLUSIONS

With Puerto Princesa the home of the famed Puerto Princesa Underground River and Tubbataha Reef, two of the UNESCO World Heritage sites, its reputation and fame would only increase with the coming years. Prompting many tourists from all over the country and the world to come and visit the province. Due to this, an increase to the aviation demand will be inevitable. With the total area of the current Puerto Princesa Airport, it is not up to standards of the International Civil Aviation Organization (ICAO). To be one of the main gateways of the Philippines, the Puerto Princesa International Airport should be of international standards. Therefore, the Puerto Princesa Airport complex should be renovated to meet the current international standards although this study will only focus on the passenger terminal as the study will be too broad. Future passenger movement and aircraft movement for a specific target year will be forecasted. For this study, the target year will be 2020 since it is the first phase for the renovation of the Puerto Princesa International Airport.

The forecasted passenger movement will then be used to determine the peak hour passenger demand for calculations of passenger terminal size and parking space required. The required passenger terminal size will be accordance to FAA (Terminal Size Design

Standards), however Philippine standards should be considered depending on the results of the forecasted passenger movement. For parking spaces requirements, the method stated in the DMIA Master Plan of Laguindingan Airport will be used. Though keeping in mind, the parking spaces requirement for international passengers will be designed for tourist buses.

Known for its eco-tourism, it is important to portray the environmentalism of the province with the first sight that will greet the tourists. The solar power technology will be used in the study as the city of Puerto Princesa is plagued with power shortages and the cost of electricity is twice than that of Metro Manila. The solar panels will be situated on the flat portion of the roof giving an illusion that the roof is made up of black panels. Not only the solar panels are environmentally friendly, but also these are clean, non-polluting, renewable and dependable compared to diesel and coal power plants.

Regarding the airport's waste management program, it is imperative that the management of the Puerto Princesa International Airport is committed in order for the program to be successful. Some sustainable programs that can be applied to the airport is proper waste identification, recover and recycle as much as possible, waste management plan program, raise awareness, and monitor for continuing improvement.

6. RECOMMENDATIONS

The group strongly recommends that the government officials of Department of Transportation and Communications (DOTC) review the proposed site development plan of the Puerto Princesa Airport Passenger Terminal.

The group also recommend for a review of the projected area. An updated result of air passenger demand is needed for further assessment of the total land area. This will result to a more sufficient design of the passenger terminal. Also, if possible, the group recommend a change in the material of the beam for sustainability instead of concrete beam, steel beams shall be used. As steel beams will be easier and practical for the passenger terminal to be expanded and can be recycled.

As the group study and evaluate the design of the passenger terminal, they found out that environmental aspects will be greatly influenced by the construction of the project. Since the passenger terminal occupies an abundant area of 12,900 m²; the group recommend a consultation to environmental engineers to assess the effects of the said building.

The group also recommend ensuring that the sewerage system has been established well. The project covers a large area, and therefore affects the environment. Consultation from a sanitary engineer must be done.

The study limits itself on the design of the structural excluding the aesthetics aspects of the building. The group recommend for a review of plans by the architects. The design established and envelope in this study was done years ago. Aesthetics and facilities are not updated and further improvements can still be done. Sustainability of the building is assessed well by the group, hence an evaluation from architects would be beneficial.

The group also recommend a re-study of the project after three years from the completion of the construction. The actual data for domestic and international passenger movement with the new passenger terminal shall be gathered to compare the difference from the past passenger terminal to the new passenger terminal. With the data gathered, a feasibility study shall be conducted if a new passenger terminal with the target year of 2040 shall be feasible.

This study presents how aspiring civil engineers from Mapua Institute of Technology address the need of Puerto Princesa, Palawan in their plan of having an efficient and sustainable airport passenger terminal. In this way the researchers can help the said port to improve their operation and level of service.

REFERENCES

- Bein, Thilo, (2006). *Intelligent Materials for Active Noise Reduction – Overview & Results*. Transport Research Arena Europe 2006, Goteborg, Sweden.
- ComplexWorld. (2013). *The Cost of Noise Reduction at European Airports*. Retrieved at www.complexworld.eu/the-cost-of-noise-reduction-at-european-airports/
- Economist.com. (2014). Solar Energy: Stacking the Deck. Retrieved at <http://www.economist.com/news/science-and-technology/21596924-way-double-efficiency-solar-cells-about-go-mainstream-stacking>
- Fann, Jean-Christophe & Rakas, Jasenka. (2011). *Greener Transportation Infrastructure: Theoretical Concepts for the Environmental Evaluation of Airports*. University of California, Berkeley, USA
- Graceffo, Antonio (June 2007). *Puerto Princesa: The Philippines' Cleanest and Greenest City*. Retrieved from www.wildasia.org/main.cfm/RTI/Puerto_Princesa
- Kim, Hee-Eun (March 2013). *Puerto Princesa Airport Development Project: Conceptual Design Report*.
- Kim, Hee-Eun (March 2013). *Puerto Princesa Airport Development Project: Performance Specifications & Parameters Report*.
- OAFAA. (2013). Recycling, Reuse and Waste Reduction at Airports: A Synthesis Document. Retrieved at <http://www.faa.gov/17ED1A1B-D446-4E10-8729-668630CAD2CC/FinalDownload/DownloadId-1412280619E089C4B812071F03501C53/17ED1A1B-D446-4E10-8729-668630CAD2CC/airports/resources/publications/reports/environmental/media/RecyclingSynthesis2013.pdf>
- The Louis Berger Group Phils., Inc. (September 2006). *Intermodal Transport Development Project: Final Report*. Note: Feasibility Study, Master Plan
- The Official Website of the City Government of Puerto Princesa. (2012). Retrieved at www.puertoprincesa.ph.