Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 08 August-2024, Page No.- 4878-4883

DOI: 10.47191/etj/v9i08.37, I.F. – 8.227

Evaluation of Runway Capacity at Fatmawati Soekarno Airport, Bengkulu

Allwy Silda Sabania[1], Widodo Budi Dermawan[2], Muhammad Isradi[3], Reni Karno Kinasih[4]

[1,2,3,4] Department of Civil Engineering, Universitas Mercu Buana, Jakarta, Indonesia

ABSTRACT: Fatmawati Soekarno Airport is one of the airports that acts as the main gateway for air transportation and the growth of the tourism economy in Bengkulu City. From the results of the study, it is known that for condition 1) the runway capacity in existing conditions in 2023 is for 30 departure operations, 25 arrival operations and 25 mixed operations with 10 aircraft movements, the capacity in existing conditions is still sufficient, but it is known that the runway needs to be added along 933 m. Meanwhile, the analysis of runway capacity in condition 2) for 30 departure operations, 24 arrival operations and 24 mixed operations with 28 aircraft movements, the current capacity is not sufficient for this movement, and geometrically to serve the international scale, it is necessary to extend the runway 717 m from the existing ideal condition equipped with runway shoulder and clearway. And the results of the analysis of condition 3) runway capacity for 30 departure operations, 26 arrival operations and 22 mixed operations with 72 aircraft movements.

KEYWORDS: Runway Capacity, Runway Geometry, Airports, ICAO, FAA.

I. INTRODUCTION

The growth of air transportation users at Fatmawati Soekarno Airport Bengkulu increased significantly throughout 2023 until the end of the third quarter. This growth is in line with the rolling tourism sector in Bengkulu City. Fatmawati Soekarno Airport management recorded a total of 607,539 passengers during the period January to December 2023. The number of passengers increased by 11.86% compared to the same period last year of 543,143 passengers. Since Fatmawati Soekarno Airport is in the process of developing into an international airport, Fatmawati Soekarno Airport has only domestic flight routes. Although only there are domestic flights the movement of the number of passengers each year shows a significant increase. (PT Angkasa Pura II (Persero) Fatmawati Airport, 2023).

Fatmawati Soekarno Airport, which was originally a domestic airport, is now in the development stage to become an international airport for modern and international standard pilgrimage flight routes. This development requires significant evaluation in facilities, infrastructure, and services offered to airport users, both for domestic and international flights.

One of the most important steps in this development is the upgrade of the airport's infrastructure, including improvements to runways, taxiways, aprons, and other supporting facilities. This refurbished infrastructure not only increases the airport's capacity, but also improves operational efficiency and flight safety.

At this time, Fatmawati Soekarno Airport only has a runway of 2,250 meters long and 45 meters wide, only able to accommodate aircraft of certain types and sizes. Limitations on the runway can hinder aircraft movement, with such dimensions of course greatly affecting the type of aircraft that will operate at the airport considering the number of passengers and aircraft movements that are increasing from year to year and the development of Fatmawati Soekarno Airport into an international airport. (Silvia et al., 2021).

II. RESEARCH METHOD

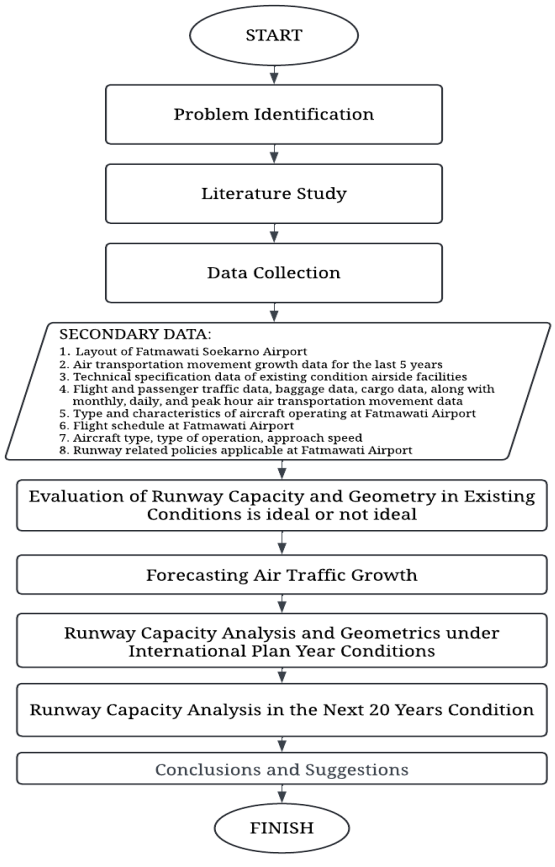

Figure 1. Flowchart

Methods used to calculate runway capacity and geometry include the use of tables, graphs, and capacity theory formulas from the FAA (Federal Aviation Administration). The FAA has established guidelines for calculating airport capacity and geometry based on various aircraft compositions and runway configurations. In addition, this study also follows the International Civil Aviation standards from ICAO (International Civil Aviation Organization) as well as some rules from the Director General of Civil Aviation Regulation (SKEP 77/IV/05) in airport design.

III.RESULT AND DISCUSSION

A. Existing Condition of Fatmawati Soekarno Airport

Fatmawati Soekarno Airport is a class I airport managed by UPT Directorate General of Civil Aviation of the Ministry of Transportation with BKS code. On October 13, 2019, the Directorate General of Civil Aviation of the Ministry of Transportation officially handed over the management of Fatmawati Soekarno Airport to PT Angkasa Pura II. The airport has a land area of 1,913,904 m², with a runway area of 101,250 m², 40 cm thick surface course, 40 cm thick base course, 40 cm thick subbase course, and subgrade with 6% CBR.

Table 1. Type of Aircraft Fatmawati Soekarno Airport

No.	Aircraft Type
Operating Aircraft	
1.	Cessna 208 Grand Caravan
2.	Airbus A320
3.	Boeing 737-800
4.	Boeing 737-900ER
Aircraft to be Operated	
1.	Boeing 767-300
2.	Airbus A330-300

B. Existing Runway Capacity Evaluation

To calculate the movement of aircraft and passengers, traffic data that occurs every month is required, which is then used to calculate the movement ratio during peak hours. This movement data is obtained from PT Angkasa Pura II Bengkulu City with a data period of one year.

a. Calculating monthly aircraft movements

$N_{month} = R_{month} \times N_{year}$

= 0,0975 × (2.328 + 2.328)

= 454 Movements

b. Calculating monthly passengers

$N_{month} = R_{month} \times N_{year}$

= 0,0941 × (300.162 + 307.733)

= 57.173 Passengers

c. Calculating daily passengers

Assume that the average number of days in a month is 30.5 days and the number of busy days in a month is 4 days, then the busy day ratio is 4 ⁄ 30.5 = 0.131. So the resulting total daily passengers are :

$N_{day} = R_{day} \times N_{month}$

= 0,131 × 57.173

= 7.498 Passengers

The average travel time of Trans Metro Pasundan Corridor 2 is calculated from a 5-day survey by recording travel times during the morning commute (06:30), midday (11:30), and evening rush hour (15:30) from Poll A at the Ikea stop to Poll B at the Alun-Alun Bandung stop.

Table 2. Existing year Aircraft and Passenger Movements

Item	Air Traffic Plan Year		
	Year	Month	Day
Aircraft Movement	4,656	454	10
Passenger Movement	607,539	57,173	7,498

In calculating runway capacity, aircraft specification data is required which is then categorized based on approach speed according to Federal Aviation Administration (FAA) regulations.

Table 3. Aircraft Category Based on Approach Speed

Category	*Approach* Speed (kn)
A	< 91 Knots
B	91 - 120
C	121 - 140
D	141 - 166
E	> 166

Types of aircraft operating on the busiest days at Fatmawati Soekarno Airport. Wednesday is recorded as the day with the most flights, so the aircraft operating schedule on that day is used as a reference.

Table 4. Evaluation of Existing Runway Capacity Against Movement

Runway **Capacity (movements)**			**Aircraft Movement**
Departure	Arrival	Mixed Operations	
30	25	25	10

The results show that the runway capacity of Fatmawati Soekarno airport can still accommodate aircraft operating in 2023 (existing conditions) with a capacity for departure 30

operations, arrival 25 operations and mixed operations 25 operations.

Evaluation of runway geometry under existing conditions involves a detailed assessment of the existing runway dimensions and configuration to ensure that the facility meets safety standards and operational efficiency. By using aircraft operating in the existing conditions of Fatmawati Soekarno airport, namely Boeing 737-900ER, because the aircraft is the aircraft that has the highest frequency of operation at Fatmawati Soekarno airport. So this runway is evaluated based on the Boeing 737-900ER operating aircraft, intended so that the runway at Fatmawati Soekarno airport can meet the geometry required by all types of aircraft operating on the runway. The required runway length is obtained by considering several factors, namely the correction factor for elevation, correction for temperature, and correction for gradient. The results obtained are as follows:

Rumus : $L_a = L_a \times F_e \times F_t \times F_g$

$L_a = 2.550 \times 1{,}0035 \times 1{,}131 \times 1{,}1$

$L_a = 3.183$ m

From the calculation of correction to elevation, correction to temperature and correction to gradient, it is obtained that the runway length required by Boeing 737-900ER operating aircraft with full load is 3,183 m long. Meanwhile, the runway length of Fatmawati Soekarno airport in the existing condition is 2,250 m, so it is necessary to develop the runway length of 933 m.

C. Air Traffic Growth Forecasting Analysis

The calculation of air traffic growth is carried out to find out how future traffic growth occurs at Fatmawati Soekarno airport, by forecasting or predicting traffic analysis based on existing traffic data from the previous year using the exponential extrapolation method. The data to be analyzed include aircraft traffic growth data, passengers, baggage and cargo with a prediction period of up to 20 years. The traffic data used in the analysis is the year data obtained from PT Angkasa Pura II Bengkulu City.

To find out how rapidly Fatmawati Soekarno airport has increased or decreased traffic from year to year, a form of data is needed that can easily show a downward or upward trend such as data in the form of a graph. In the aircraft data graph, passenger data, baggage data and cargo data show that traffic data at Fatmawati airport tends to increase every year but there is a decline that lasts for several years when the Covid – 19 virus is rampant in Indonesia. So that the data in 2019 – 2020 is not included in the analysis data because Fatmawati Soekarno airport experienced a total lockdown, but after that in 2021 – 2023 it began to increase again.

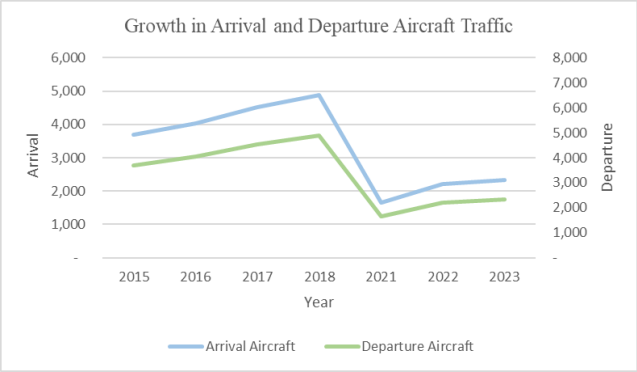

Figure 2. Aircraft Growth Chart

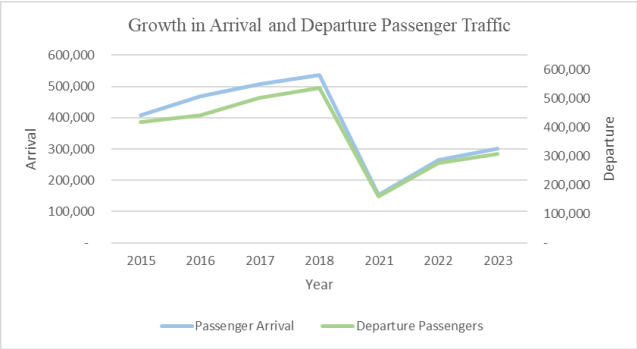

Figure 3. Passenger Growth Chart

From the average r results that have been obtained previously, the value (Y(t + n)) can be determined, namely the amount of traffic that occurs in year n. The forecasting that is done is forecasting with a period of up to 20 years in the future, namely until 2044. With the results presented in tabular form as follows:

Table 5. Recapitulation of Forecasting the Number of Aircraft Traffic

Year	Airplane	
	Arrival	Departure
2015	3,688	3,676
2016	4,031	4,042
2017	4,528	4,542
2021	1,646	1,643
2022	2,213	2,213
2023	2,328	2,328
2024	**2,555**	**2,559**
2034	**6,487**	**6,581**
2044	**16,469**	**16,928**

Table 6. Recapitulation of Forecasting the Amount of Passenger Traffic

Year	Passengers	
	Arrival	Arrival
2015	407240	417077
2016	468,436	441,690

2017	507,528	503,494
2021	152,944	160,359
2022	265,694	277,489
2023	300,162	307,377
2024	**329,298**	**334,517**
2034	**831,605**	**779,631**
2044	**2,100,130**	**1,817,022**

Table 7. Recapitulation of Forecasting the Amount of Baggage Traffic

Year	Baggage (kg)	
	Arrival	**Departure**
2015	2,137,335	2,100,335
2016	2,248,816	2,148,816
2017	2,882,125	2,550,125
2021	899,580	895,581
2022	2,086,899	1,858,218
2023	2,347,329	2,264,033
2024	**2,772,932**	**2,403,963**
2034	**14,675,455**	**4,379,036**
2044	**77,668,328**	**7,976,808**

D. Peak Hour Aircraft and Passenger Movement Analysis

After analyzing the traffic growth that occurs, the next step is to analyze the peak hour in the 2034 plan year. Rush hour analysis is an analysis of the daily movement of the plan so that the total movement that occurs every day can be known. The purpose of doing this analysis is to get the total movement every day of Fatmawati Soekarno airport, so that further analysis can be done on the adequacy of operations that occur on the runway in the plan year of Fatmawati Soekarno airport.

Table 8. Peak Hour Traffic Movement in the Plan Year

Item	Air Traffic Plan Year		
	Year	Month	Day
Aircraft Movement	13,069	1,274	28
Aircraft Movement	1,611,237	151,627	19,885

E. Calculating International Plan Year Runway Capacity

Runway is an important part of an airport because there the operational process of aircraft such as takeoff and landing occurs. In using the runway, there are basic rules made by the international aviation federation that aim to maintain safety during the runway operational process.

Table 9. Plan Year Runway Capacity Analysis of Movement

***Runway* Capacity (movements)**			**Aircraft Movement**
Departure	**Arrival**	**Mixed Operations**	
30	24	24	28

From the runway capacity analysis results, it can be concluded that at least one additional runway is needed to serve aircraft movements during peak hours in 2034. To maximize the runway performance of Fatmawati Soekarno airport, several efforts can be made such as adding the ideal number of exit taxiways, adjusting the exit taxiway angle to serve the aircraft movement optimally, or determining the composition of the operating aircraft category to achieve maximum runway capacity.

The correction factor for gradient (Fg) in runway length calculation is used to take into account the impact of runway slope on aircraft takeoff performance and distance requirements. In the ICAO reference (2013), the effective gradient for Fatmawati Soekarno airport is in code 4E = 1%. The following is the calculation for the Fg formula:

Rumus : $Fg = 1 + 0{,}1 \times G$

$Fg = 1 + 0{,}1 \times 1$

$Fg = 1{,}1$

Thus, the required runway length is obtained by taking into account several factors, namely the elevation correction factor, temperature correction, and gradient correction. The results obtained are as follows:

Rumus : $L_a = L_a \times F_e \times F_t \times F_g$

$L_a = 2.700 \times 1{,}0035 \times 1{,}131 \times 1{,}1$

$L_a = 3.371$ m

Meanwhile, the runway length requirement for wet landing is :

Actual landing distance × 1,92 = 2020 × 1,92 = 3859,2 m

Then the runway length used is 3900 m. Thus, an additional runway length of 717 m is required from the existing ideal runway.

F. 20 Year International Runway Capacity

In the previous calculation of runway capacity is the condition of the development plan stage to an international scale, so the data used is data - data assumptions based on data in the existing year. At the stage 20 years later in 2044 it is assumed that the airport development project to become international scale has been completed and is already in operation, at this stage there is a change in the runway usage time.

Assuming that the runway becomes longer and the types of aircraft operating are still the same as in the 2034 plan year, it will take longer to reach the threshold so that the runway usage time will also increase. In addition, there is also a change in the percentage of aircraft mix if in the international scale plan year the aircraft operating per day is 28 aircraft.

Table 10. Aircraft Baggage and Cargo Capacity

No	Aircraft Type	Capacity	Pax Weight	*Payload*	Baggage and Cargo Weight
		Pax	**Kg**	**Kg**	**Kg**
Operating Aircraft					
1.	Cessna 208 Grand Caravan	14	910	1,520	610
2.	Airbus A320	180	11,700	16,600	4,900
3.	Boeing 737-800	189	12,285	20,540	8,255
4.	Boeing 737-900 ER	215	13,975	20,865	6,890
Total		**598**	**38,870**	**59,525**	**20,655**
Aircraft to be Operated					
1.	Boeing 767-300	350	22,750	52,390	29,640
2.	Airbus A330-300	440	28,600	45,000	16,400
Total		**790**	**51,350**	**97,390**	**46,040**

The baggage and cargo capacity for each aircraft type is obtained, and the value is the weight that the aircraft can carry for one trip. Then the value can be converted into the number of aircraft operating. If the type of aircraft to be calculated is an operating aircraft with a total of 6 types of aircraft using the assumption that all existing capacity is used, then the capacity that can be accommodated by 6 aircraft is 66,695 kg.

To determine the busy month, the number of flights each month with the highest ratio is required. The month with the highest ratio is considered a busy month, the calculation of the highest ratio has been done in the calculation of existing Peak Hour traffic movements.

Table 11. Peak Hour Traffic Movement 20 Years in the Future

Item	Air Traffic in the Next 20 Years		
	Year	Month	Day
Aircraft Movement	33,397	3,257	72
Aircraft Movement	3,917,152	368,627	48,345

From the results of peak hour calculations, different aircraft movement results were obtained. The amount will be used to determine the runway capacity for the next 20 years. but still must be reconsidered, because in this case the value of traffic forecasting does not always get accurate results or in accordance with what will happen in future conditions.

Table 12. Runway Capacity Analysis for the Next 20 Years

***Runway* Capacity (movements)**			**Aircraft Movement**
Departure	**Arrival**	**Mixed Operations**	
30	26	22	72

IV. CONCLUSIONS

The things that can be concluded from the results of the calculation and planning analysis in this Final Project include the following:

1. Runway capacity in existing conditions shows that the runway capacity of Fatmawati Soekarno Airport can still accommodate aircraft operating in 2023 (existing conditions) with a capacity for departure 30 operations, arrival 25 operations and mixed operations 25 operations. In addition, based on the evaluation of the existing condition geometry, 3,183 m is obtained as the ideal existing runway, while the existing condition runway is 2,250 m with an existing condition runway width of 45 has met the classification. For other airside facilities in existing conditions, they meet the requirements of the International Civil Aviation Organization (ICAO) with code 4C.
2. The runway capacity in the international scale plan year condition (2034) shows that the runway is not able to serve the number of aircraft movements that occur, with aircraft movements in the plan year being 28 movements. Meanwhile, the capacity of the plan year conditions for departure 30 operations, arrival 24 operations and mixed operations 24 operations. By analyzing the runway geometry in the international scale plan year with a code that has changed to 4E, a runway length of 3,900 m and a runway width of 52.5 m is obtained with a runway shoulder and clearway.
3. The runway capacity in the 20-year condition after international scale shows that the runway is not able to serve the number of aircraft movements in the 20 years after international scale is 72 movements. Meanwhile, the capacity of the 20-year condition after international scale for departure 30 operations, arrival 26 operations and mixed operations 22 operations.

REFERENCES

1. Agung, I. G., Mas, A., Yuniar, D. C., & Purwaningtyas, D. A. (2022). Analysis of Saturated Capacity on the Runway Based on Advisory Circular 150 / 5060-5 As a Study Material for Airport Management Learning. 3(3), 373–381.

https://doi.org/10.46843/jiecr.v3i3.120
2. Airlines Inform. (n.d.-a). Airlines Inform Airbus A330-300. https://www.airlines-inform.com/commercial-aircraft/airbus-a330-300.html
3. Airlines Inform. (n.d.-b). Airlines Inform Boeing 737-900ER. https://www.airlines-inform.com/commercial-aircraft/boeing-737-900.html
4. FAA. (2014). Airport design advisory circular 150/5300-13A. Federal Aviation Administration.
5. Gujarati, D. N., Corlett, W. J., & Aigner, D. J. (2003). Basic Econometrics. In The Economic Journal (Vol. 82, Issue 326). https://doi.org/10.2307/2230043
6. Horonjeff, R., McKelvey, F., Sproule, W., & Young, S. (2010). Planning and design of airports. McGraw-Hill Companies.
7. Horonjeff, R., Mckelvey, F. X., Sproule, W. J., & Young, S. B. (2010). Planning and Design of Airports.
8. ICAO. (2006). Manual on Air Traffic Forecasting. International Organization, 14(3), I-1-III–30.
9. ICAO. (2018). Procedures for Air Navigation Services (PANS) - Aircraft Operations - Volume I - (Doc 8168-1. In Procedures for Air Navigation Services: Vol. I (Issue November).
10. Indonesia, P. (2005). SKEP 77-VI-2005 Dirjen Perhubungan.
11. International Civil Aviation Organization. (2013). ICAO Annex 14, 6th Edition, July 2013: Vol. I (Issue July).
12. International Civil Aviation Organization (ICAO). (2016). Aerodromes Design & Operations - Annex 14. In Convention on International Civil Aviation: Vol. I (Issue July). http://cockpitdata.com/Software/ICAO Annex 14 Volume 1 7th Edition 2016
13. Kementerian Perhubungan. (2008). KM 6 Tahun 2008 Tentang Kriteria Klasifikasi Organisasi Unit Pelaksana Teknis Bandar Udara. https://jdih.dephub.go.id/assets/uudocs/permen/2008/km_no_6_tahun_2008.pdf
14. Lewa, M. S., Ariawan, P., & Budiarnaya, P. (2020). Evaluasi Perkerasan Landasan Pacu Pada Bandara Pattimura Dengan Membandingkan Metode FAA dan FAARFIELD Software. 3(2), 1–8.
15. Mapeda, P. J., Pandey, S. V, & Lalamentik, L. G. J. (2020). Analisis Kapasitas Landasan Pacu (Runway) Pada Bandar Udara Internasional Sam Ratulangi Manado. 8(1).
16. Pasapan, H. P., Ircham, & Anggorowati, V. D. A. (2021). Evaluasi Landas Pacu Bandar Udara (Studi Kasus : Bandar Udara Pongtiku Tana Toraja , Sulawesi Selatan). 02(01), 55–66.
17. Ramadhan, F. N., Rintawati, D., & Sari, C. (2023). Analisis Kapasitas Air Side (Studi Kasus : Bandar Udara Internasional Lombok) Analysis Air Side Capacity (Case Study : Lombok International Airport). 01(02).
18. Ricardianto, P., Putra, A. P., Adi, E. N., Wardana, A., Rafi, S., Ozali, I., & Endri, E. (2022). Evaluation of the Two Runway Queuing System : Evidence from Soekarno-Hatta International Airport in Indonesia. 17, 142–152. https://doi.org/10.37394/23203.2022.17.16
19. Sari, A. N., Amanah, T., Pratama, M. A. S., Suryan, V., & Amalia, K. R. (2023). Evaluasi Runway Bandara Fatmawati dengan Menggunakan Software Comfaa. 10(1), 151–158.
20. Silvia, S., Suparma, L. B., & Utomo, S. H. T. (2021). Analisis Pengembangan Geometrik Runway Bandar Udara Fatmawati Soekarno Kota Bengkulu. Journal of Civil Engineering and Planning, 2(2), 120. https://doi.org/10.37253/jcep.v2i2.5201
21. Suprianto, H., Arifin, T. S. P., & Haryanto, B. (2020). Analisis Perhitungan Kapasitas Runway Pada Bandar Udara Internasional Aji Pangeran Tumenggung Pranoto Samarinda. 4, 20–38.
22. Susanto, J., Nisumanti, S., & Qubro, K. Al. (2022). Analisis Kapasitas Landasan Pacu (Runway) Bandar Udara Internasional Sultan Mahmud Badaruddin II Terhadap Jumlah Penumpang Pada Masa Pandemi Covid-19. 7, 219–233.
23. Tascon, D. C., & Olariaga, O. D. (2021). Air traffic forecast and its impact on runway capacity . A System Dynamics approach. 90(November 2019). https://doi.org/10.1016/j.jairtraman.2020.101946
24. Boon, S., Johnston, B. and Webber, S., 2007. A phenomenographic study of English faculty's conceptions of information literacy. *Journal of Documentation*, [e-journal] 63(2), pp.204 - 228. http://dx.doi.org/10.1108/00220410710737187.
25. Wang, Z. Joseph H.W. Lee and Mengzhen Xu. 2012. Ecohydrolic and eco-sedimentation studies in China. *Jornal of Hydrolic Research* [e-Journal] 51(1), pp.55-62. doi:10.1080/00221686.2012.753554