SPACE ALLOCATION FOR COMMERCIAL ACTIVITIES AT LOW COST AIRPORT TERMINAL

Batari Saraswati
International Development Engineering, Tokyo Institute of Technology
2-12-1 O-okayama Meguro-ku, Tokyo 152-8550, Japan
Email: batari@tp.ide.titech.ac.jp

Shinya Hanaoka
International Development Engineering, Tokyo Institute of Technology
2-12-1 O-okayama Meguro-ku, Tokyo 152-8550, Japan
Email: hanaoka@ide.titech.ac.jp

ABSTRACT

The impact of low-cost carriers’ (LCCs’) pressure on the level of aeronautical charges has encouraged the airport authorities to seek ways of generating more non-aeronautical revenues. One of the main sources of non-aeronautical revenue is the revenue generated from commercial activities inside the terminal. For low-cost terminal (LCT), this issue becomes more important, seeing LCT as the main server of LCCs in the airport. We propose a commercial space allocation model that meets low-cost business model. LCC passenger preferences and dwelling time are considered in the space allocation model. The optimization function allocates space needed by each concession in certain location to ensure revenue maximization. This model is applied in Terminal 3 Soekarno-Hatta International Airport Jakarta, as a case study to demonstrate the feasibility and usefulness of the proposed model for LCT commercial space allocation. The result shows that stores with highest potential revenue should be allocated in the more accessible positions with higher passenger flow. Moreover, sales from the airside accounts for greater amount of retail revenue.

Keywords: low-cost terminal, commercial space, dwelling time, concession preferences.
1. Introduction

The low-cost carrier (LCC) industry is growing rapidly for the past decade resulting in a new trend in aviation industry. LCCs have brought airline industry into more competitive and careful management of all cost items. They have been exerting increasing pressure on the airport industry to lower the level of aeronautical fees (Doganis, 2002). The pressure has influenced the revenue received by the airport; therefore it encourages the airports to seek ways of generating more revenues to ensure their profitability. This issue becomes more vital for low-cost terminal (LCT), seeing LCT as the single terminal that specifically serve LCCs’ activity in the airport.

Generating more non-aeronautical revenue has been seen as one way to undertake this issue. LCCs claims their passengers tend to spend more on catering and shopping facilities at airports because they do not provide in-flight services such as catering and newspapers. This condition pushes airport to provide good commercial facilities in LCT which generally requires more commercial space. However, the ability of airports to generate commercial revenues from the LCTs has been subject of much debate among airport planners. LCTs have been designed with restricted space for operational and commercial functions in order to minimize capital investment. The limited space in the terminal, the dominant of leisure passengers and simpler passenger flow have to be considered for concession development. In this context, it is important to ensure proper space allocation in LCT in order to fully take advantage of commercial opportunities that exist within LCC passengers.

This study intends to propose commercial space allocation model for airport’s LCT. Further analysis into airside and landside split of commercial area is also presented to reach better space allocation scheme. The next section contains literature review. Section 3 discusses concessions in LCT and its characteristics. Section 4 provides methodology and it is applied in a case study presented in Section 5. Finally Section 6 draws conclusion on the results of research.

2. Literature Review

Research about concession in airport terminals has been done as far back as Hasan and Braaksma (1986). They measured utilization factor of each type of people using data of seven Canadian airports by comparing the mean total person-minutes spent in concessions to the mean total idle person minutes spent in terminal. The most highly utilized market was the non-passengers, while terminating and connecting passengers have the lowest utilization.

The researches emerge into study about the determinants of airport non-aeronautical revenue, such as the importance of passenger demography (Appold and Kasarda, 2006), the relationship between passenger dwelling time and concession consumption (Torres et al., 2005), shopping behavior and motivation (Geuens et al., 2004).
Studies assessing the implications of LCC passengers for the airports’ non-aeronautical revenue recently became a tremendous topic of research. McDonald and Gillen (2003) cited in Lei and Papatheodorou (2010) studied the impact of LCCs on Canadian airports’ non-aviation revenue. WestJet and Air Canada passengers are used as proxies for the two business models, respectively. The explanatory variables include LCC passengers, full service carrier passengers, a time trend and airport dummies. They find that an additional WestJet passenger spends C$6.20 at the airport while an incremental other passenger spends C$1.22. The reasons, asserted by McDonald and Gillen, are twofold. First, because LCCs do not provide in-flight meals, their passengers commonly purchase food at the airport terminal, thus generating higher commercial revenue. Second, LCCs attract more ‘meeters and greeters’ as there is a higher proportion of leisure travelers among LCC passengers; these ‘meeters and greeters’ can further contribute to the airports’ concessionary income.

Castillo-Manzano (2010) analyzed the factors that influence a passenger’s decision to make a purchase at an airport store or to consume food and beverages at a catering facility during his/her stay at a Spanish regional airport. The bivariate probit analysis showed LCC passengers have the same likelihood to make a purchase or consumption but when they do decide to make expenditure, the amount they spend is 7% less than other passengers.

Lei and Papatheodorou (2010) observed whether LCC passengers can generate higher than average commercial revenues. A panel data on 21 UK airports over the period of 1995/96 to 2003/04 are used in this study. The result shows LCC passengers make lower marginal contribution to airport commercial revenue than other passengers (full-service and charter carriers). Passengers flying with full service and charter carriers tend to spend more at specialist stores selling luxury products and these stores provide important revenue sources for airports. In contrast, LCC passengers might mainly spend at places such as restaurants and newsagents, which supply less lucrative revenue to airports.

The above discussion shows that mixed evidence has been produced about the effect of LCCs on airports’ commercial revenue; however most of the literatures agree that passengers on LCCs are by no means always ‘budget’ shoppers at airports, particularly because LCC passengers have the need for food and beverage facilities because of the lack of free-in-flight catering (Graham, 2009).

Previous researches did not focus much in the topic of space allocation for commercial activity in airport terminal. One of the exceptions is Hsu and Chao (2005) who developed a space allocation model for optimizing space allocation for several stores at different locations in international terminal. CKS International Airport in Taiwan is used as a case study to demonstrate the application of the model. The result of their study showed that to maintain the same public facility service level, the space required for commercial activities increases proportionally with passenger volume, while the concession revenue does not increase by the same proportion, but instead it depends in the allocated locations.
3. Concessions in LCT

To maximize the concession revenue of an airport, the total sales of each concessionaire have to be monitored. Total sales by concessionaires, according to Doganis (1992) depend on three factors. First, the total traffic handled by an airport and, in so far as passengers are the single largest source of sales by concessionaires, the characteristics of its passenger traffic. Second, the total amount of space allocated to those concessionaires operating shops, catering outlets, services and so on and the location of that space within the terminal building, and third, the skill of the concessionaires themselves in generating sales. In determining space allocation for commercial facilities in LCTs, all those factors have to be taken into account while maintaining the constraints of LCT as simple terminal. The key features of LCTs are that they are small and functional, being designed for point-to-point rather than transfer passengers, with no frills such as airline lounges, might results in much simpler passenger flow, less area and different passenger dwelling time.

Focus in this study will be on individual customers who buy commercial goods at the airport. There are, of course, other consumers such as the airlines and handling agents who also generate concessions and rental revenues by paying for the use of office spaces, check-in desk, lounges, in-flight kitchen, and so on; however these activities will not be covered in this study.

3.1 Type of Concession in LCT

The very nature of simple design of LCTs might results in less extensive range of facilities compared with ordinary terminal. For instance, Terminal 1 and 2 in Changi Airport offer more extensive choices of concession, including a karaoke, a swimming pool, and bathing room in order to increase customer satisfaction, sales of duty-free and the usage of leisure facilities (Kim and Shin, 2001). Meanwhile, Budget Terminal in Changi only offer basics concessions, such as food and beverage, convenience stores and less number of duty-free stores. This arrangement is reasonable since LCC passengers’ needs are different from full-service carrier (FSC) passengers’. Airport planners need to pay attention to the possible impact of culture and behavior on the development of commercial activities in LCT. For example, the retail and catering facilities at the new Brussels National Airport Low Cost Pier have been tailored to meet the needs of low-fare passengers. Here, with meals usually an optional extra on low-cost flights, the airport introduced a wide range of ‘grab-and-go’ style products to meet passenger demands.

In the existing LCTs, commercial facilities that are provided are mainly basics: (1) Food and beverage, (2) Bookstores and newsstand, (3) Convenience Stores, (4) Gift/Souvenir stores, (5) Retails and electronics, and (6) Duty-free stores. LCTs also provide basic passenger facility services, such as car rental and banks/foreign exchange and advertising spaces. This arrangement is aligned with LCC passengers’ shopping motivation that is more functional than experiential/hedonic.
Table 1. Location of concessions in several LCTs

<table>
<thead>
<tr>
<th>Concession Type</th>
<th>Departure Landside</th>
<th>Departure Airside</th>
<th>Arrival Airside</th>
<th>Arrival Landside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal 1 Budapest</td>
<td>1</td>
<td>1, 2, 3, 4, 5, 6</td>
<td></td>
<td>1, 2</td>
</tr>
<tr>
<td>Budget Terminal Changi</td>
<td>1, 2, 3, 5</td>
<td>1, 2, 3, 4, 5, 6</td>
<td>6</td>
<td>1, 5</td>
</tr>
<tr>
<td>LCCT KLIA</td>
<td>1, 5</td>
<td>1, 2, 3, 4, 5, 6</td>
<td></td>
<td>4, 5</td>
</tr>
<tr>
<td>Terminal 5 JFK</td>
<td>1, 2</td>
<td>1, 2, 5, 6</td>
<td></td>
<td>1, 2</td>
</tr>
</tbody>
</table>

Note: ① refers to food & beverage, ② refers to bookstores/newsstand, ③ refers to gift/souvenir store, ④ refers to convenience store, ⑤ refers to retails, ⑥ refers to duty-free store. Source: airport websites

Based on the observation of concession stores provided in LCTs, this study categorizes the store variety in LCT into four main types. The categorizing is based on the type of products offered, similarity of passenger behavior and amount of time needed to make a purchase in each concession type.

(1) **Food and Beverage Store** that provide variety of foods and drinks. There are selections such as food-court, sit-down restaurants, coffee shop, bars, and grab-and-go food stalls.
(2) **Convenience Store** that provide travel convenience such as books, newspaper, general medicine, and snacks. This type of store usually is a combination of newsstand and typical convenience store.
(3) **Specialized Store** that provide specified retails goods. Each store provides one variety of goods such as clothes, jewelry, toys, confectionery and electronics.
(4) **Duty-Free Store** which is a retail outlets that do not apply local or national taxies and duties. Duty-free store mainly found in international zone of airport terminal.

3.2 **The Commercial Contract**

There are various contracts and agreements in which commercial facilities can be provided at airports. This contract decides the degree to which an airport authority becomes involved in operating the various concessions available within its airport. According Kim and Shin (2001), there are seven types of agreement: wholly-owned subsidiary, direct operation, direct lease, joint venture, fee management contract, master concessionaire, developer approach.

LCT in different airport has different type of concession management. In KLIA, all the concession activities, including the one in LCCT, are managed by Malaysia Airport Niaga Sdn Bhd, as a wholly-owned subsidiary of the airport authority, Malaysia Airports Holdings Berhad

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1 Passenger service facility such as banks, car rental and foreign exchange is also an important part in LCT concession. However these facilities will not be discussed in this study since these facilities do not require many spaces and can be more flexibly located in any part of terminal.
MAHB holds a share capital in Malaysia Airport Niaga Sdn Bhd and does not involve in any operation related with commercial activities within all terminals.

Concessions in all terminals of Changi Airport Singapore are managed through direct lease agreement. The airport authority leases space in designated location through tender process. Beforehand, the authority defines what kind of concession will be tendered along with the intended location. Through direct lease agreement, the tenants should report their monthly gross revenue to the authority. Depending on the gross revenue for the month, the tenants pay either a percentage of revenue or a minimum guaranteed sum, whichever is higher for each month.

**Table 2. Concession management in several LCTs**

<table>
<thead>
<tr>
<th>Low Cost Terminal</th>
<th>Concession Management</th>
<th>Operator</th>
<th>Share of authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCCT KLIA</td>
<td>Wholly-owned subsidiary</td>
<td>Malaysia Airport Niaga Sdn Bhd</td>
<td>Airport Authority receives share of capital</td>
</tr>
<tr>
<td>Budget Terminal</td>
<td>Direct lease</td>
<td>Changi Airport Group Authority</td>
<td>Airport Authority receives percentage of monthly gross revenue or minimum guaranteed sum</td>
</tr>
<tr>
<td>Terminal 5 JFK</td>
<td>Fee management contract</td>
<td>JetBlue Airways</td>
<td>Airport Authority receives percentage of concession revenue fee in addition to lease fee paid by JetBlue</td>
</tr>
</tbody>
</table>

Source: Annual Reports JetBlue 2009, Changi Airport website, KLIA website

Terminal 5 in the JFK is operated differently from LCT in Changi and KLIA. Its operational is contracted to JetBlue Airways, the single user of Terminal 5. In October 2008, JetBlue began operating out of Terminal 5. The construction and operation of this facility is governed by a lease agreement that executed with the Port Authority of New York. JetBlue later on subleased the portion of Terminal 5 that is intended to commercial activities to the retailers. Minimum lease payments due to JetBlue are subject to various escalations and also include a percentage of gross receipts of the shops, which may vary from month to month. The Port Authority will also derive a percentage of the concession fees from sales in the terminal building.

The commercial contract in LCT differs from one to another. However, it typically involves the retailer paying a percentage of sales or gross revenue to the operator, often in addition to agreeing a minimum annual guaranteed amount.

### 4. Methodology

This study develops optimization model to achieve revenue maximization from commercial activity in LCT. The model ensures the available space in the departure area will be located efficiently for each concession type. This study focus on departure area since departure area is counted as more reliable source of commercial revenue compared to arrival area. Departure
passengers, despite their limited dwelling time, they are the main users of concession in terminal. Arrival passengers do not contribute as high as departure passengers despite their flexibility of time because their concern is for their baggage and often they need to leave from airport as soon as possible.

This study considers the special characteristics of LCT by taking into account LCC passenger preferences toward concession type and also departure passenger dwelling time. These two parameters help to estimate how many potential buyers in each concession type for certain period of time.

(1) Passenger preferences toward concession
Information about preference toward concession is important to determine which concession should be provided in the LCT. Passenger preference is influenced by many factors, such as demography and purpose of travel.

(2) Passenger dwelling time
The concept of dwelling time is central to determining the number of simultaneous occupants in terminal (de Neufville and Odoni, 1992). Dwelling time is the amount of available discretionary or slack time that passengers spend in the various parts of the terminal after completing all compulsory activities (check-in process, security and immigration control process).

4.1 Space Allocation Model
The basic idea of the model is to allocate space for commercial activity in LCT that ensures revenue maximization. The optimization function 4.1 tries to define space for each concession type by estimating its potential revenue. Let TR represents the total concession revenue in the LCT; the problem can be formulated as below:

\[
Max \ TR = \sum_{k=1}^{n} \sum_{j=1}^{m} \sum_{l=1}^{n} R_{ijk} \ X_{ijk} \\
\]

Subject to:

\[
\sum_{i=1}^{n} X_{ijk} \leq A_{jk} \quad \forall k = 1, \ldots, l; \ j = 1, \ldots, m \\
\sum_{j=1}^{l} X_{ijk} \leq S_{ij} \quad \forall i = 1, \ldots, n; \ j = 1, \ldots, m
\]

Where:

\[i = 1, \ldots, n\] index for type of concessions that are required in LCT
\[j = 1, \ldots, m\] index for concession location in departure area, consist of two regions, departure airside and landside
The revenue gained by airport authority is determined by the management contract between the concessionaires and the authority. Most airports with LCT have chosen to contract out these services to specialist retail and F&B companies. This typically involves the retailers paying a percentage of sales to the airport operator, often in addition to agreeing a minimum annual guaranteed amount (Graham, 2008). The formula 4.4 below suggests that the concession revenue is calculated based on charge per square meter area, in addition to certain percentage of sales.

\[
R_{ijk} = (C_{ijk} AS_i + AC_{ijk} F_i) PB_{ijk}
\]

Where:

- \(C_{ijk}\) concession fee per square meter for each concession type and location ($/m)
- \(AS_i\) average space required per customer for concession type \(i\) (m/person)
- \(AC_{ijk}\) average consumption per customer for concession type \(i\) in location \((j,k)\) ($/person)
- \(F_i\) concession charge based on certain proportion of store revenue (%)
- \(PB_{ijk}\) number of potential buyers for each concession type \(i\) in location \((j,k)\) (person)

### 4.2 Estimation of Number of Potential Buyers

This study uses the concept of potential buyers proposed by Hsu and Chao (2005). Potential buyers means individual that can reach certain concession \(X_{ijk}\) and remain there longer than the shortest duration required for consumption activities. This concept considers passenger dwelling time as an important variable in the model to estimate how many concessions an individual passenger can visit.

We take passenger dwelling time into account to estimate the number of potential buyers. Passenger dwelling time is divided into several ranges to explain the variation of passenger consumption time \((TO_i)\). The \(TO_i\) is distributed based on the duration of the dwelling time itself. Passengers who have longer dwelling time tend to take longer time to undertake consumption activities in concessions, e.g. minimum consumption time for passengers who have more than 80-minutes dwell time is different from those who only have 20-minutes. Passengers who have
80-minutes dwell time may choose sit-down restaurants, while passengers who only have 20-minutes dwell time, they may choose grab-and-go food stalls, and therefore it results in different consumption time. In the case study, we divided passenger dwelling time into 20-minutes ranges (1 – 20 min, 21 – 40 min, 41 – 60 min, 61 – 80 min, and >80 min).

Passenger preference toward concession is also incorporated into the model to get better estimation of potential buyers, where $n$ number of concessions results in $n!$ preference types. For example, three types of concessions in domestic terminal, food & beverage (FB), travel convenience (TC) and specialized retail (SR), generate 6 types of preferences: (1) Passengers who prefer FB better than TC and consider SR as the last option ($FB > TC > SR$), (2) Passengers who prefer to shop in SR more than FB and consider TC as the last option ($SR > FB > TC$), (3) $TC > SR > FB$, (4) $TC > FB > SR$, (5) $FB > SR > TC$, and (6) $SR > TC > FB$. We assume that the preferences reflect the sequences in undertaking commercial activity. Passengers start their shopping activity by visiting their most preferable concession first. They continue to visit other less preferable concessions as long as they have time in hand.

By notifying those two parameters, we defined number of potential buyers in departure airside and landside as follows, where $PB_{ijk}$ denotes the number of potential buyers of concession type $i$ in location ($j,k$). We notify $j = 1$ for area departure airside and $j = 2$ for departure landside.

### 4.2.1 Number of Potential Buyers in Airside

Departure airside is defined as the secured area beyond passport control that can only be accessed by departure passengers who have valid ticket and have completed check-in, security and immigration processes. All the departure passengers who have dwelling time can be categorized as potential buyers in concession stores. Passenger dwelling time in airside can be calculated by subtracting flight boarding time with passenger check-in time and duration time to complete all compulsory procedure. Walking distance to complete all compulsory procedure is also important to be taken into account. Let $\theta_{pf}$ in Equation 5 denotes the airside dwelling time of departure passenger $p$ who take flight $f$, where shortly $\theta_{pf}$ is expressed as probability distribution function $F(\theta) d\theta$. $PB_{ijk}$ denotes the number of potential buyers for concession $i$ in departure airside in location $k$.

\[
\theta_{pf} = tb_f - th_{pf} - (tc + ti + ts + \frac{d_f}{v})
\]

\[
PB_{i1k} = \sum_f \sum_g \sum_v PB_{i_2gk} P_f e_v
\]

\[
PB_{i_2gk} = \begin{cases} 
\int_{b_g}^{b_g} F(\theta) d\theta; & \text{if } b_g - T \geq TO_{i_2g} \text{ where } T = T + TO_{i_2g} + \frac{d_k}{v} \\
0; & \text{otherwise}
\end{cases}
\]
Where:

- $p$: index to notify each departure passenger
- $f$: index for departure flight
- $g$: index for number of dwelling time, for every time range we set the lower boundary as $a_g$ and upper boundary as $b_g$
- $v$: index for number of passenger preference types toward concessions ($n$ type of concessions in LCT results in $n!$ passenger preferences)
- $\theta_{pf}$: dwelling time of passengers $p$ who take flight $f$
- $tb_f$: boarding time of departure flight $f$
- $th_{pf}$: check-in time of departure passenger $p$ who take flight $f$
- $t_c$, $t_s$, $t_i$: time required for passenger to complete check-in, security, immigration processes, respectively
- $D_f$: total walking distance of passenger flight $f$ to complete all compulsory processes
- $V$: average walking distance of passengers
- $PB_{i1k}$: number of potential buyers of concession $i$ in departure airside in location $k$
- $PB_{ivgk}$: number of potential buyers of concession $i$ in location $k$, who has $g$ dwelling time range with preference $v$
- $P_f$: number of passengers in flight $f$
- $e_v$: ratio of passengers who have preferences type $v$ to total passengers.
- $F(\theta)d\theta$: passenger dwelling time distribution in airside area
- $TO_{ivg}$: minimum time needed to make a purchase in concession $i$ for passenger who has dwell time in range $g$ with preference $v$
- $T$: temporary variable that denotes the accumulation of passenger shopping time, initial value of $T = 0$
- $D_k$: walking distance to store location $k$

Equation 7 calculates number of the potential buyers in every concession as the sum of those who have dwell time range more than minimum time required to undertake consumption activity $(b_g - T \geq TO_{ivg})$. Passengers will proceed to the next concession until their dwelling time is no longer sufficient to do so $(T = T + TO_{ivg} + \frac{D_k}{v})$.

### 4.2.2 Number of Potential Buyers in Landside

Departure landside is defined as the area before the passport control which can be accessed by anyone since it has no entry barriers. Well-wishers and departure passengers are the main users of concession in this area. Well-wishers are the people who accompany passengers to the airport. They accounts for significant proportions of airports access trips and some use of airport facilities. We assume that departure passengers who use concession in the area are usually the one who arrive before the check-in counter opens. Once passengers finish their check-in process, they will directly go to the departure gates through security and immigration process.
Passenger dwelling time in landside can be obtained by subtracting check-in counter open time with passenger arrival time in the terminal. Let $t_{pf}$ in Equation 8 denotes the landside dwelling time of departure passenger $p$ who take flight $f$, where shortly $t_{pf}$ is expressed as probability distribution function $F(t)dt$. $PB_{i|k}$ in Equation 9 denotes the number of potential buyers for concession $i$ in location $k$ in departure landside area.

$$t_{pf} = th_f - ta_{pf}$$ (8)

$$PB_{i|k} = \sum_f \sum_g \sum_v PB_{ivgk} P_f e_v + \sum_f P_f r w_{ik}$$ (9)

$$PB_{ivgk} = \int_a^b F(t)dt; \text{if } b_g - T \geq T O_{ivg} \text{where } T = T + T O_{ivg} + \frac{d_k}{V} \text{; otherwise}$$ (10)

Where:
- $t_{pf}$: dwelling time for departure passenger $p$ who wait for check-in time flight $f$
- $th_f$: counter check-in time for flight $f$
- $ta_{pf}$: arrival time of passenger $p$ who take flight $f$
- $r$: ratio of well-wishers to departure passengers
- $w_{ik}$: probability of well-wishers to choose concessions type $i$ in location $k$

5. Case Study

This study uses Terminal 3 Soekarno-Hatta International Airport as an example to demonstrate the feasibility of the constructed models. Soekarno-Hatta International Airport is located in Jakarta, Indonesia. Terminal 3 was a renovation of Hajj Terminal. The concept and facilities provided in Terminal 3 reflect the concept of simplicity, cost and time minimization. It uses two-stories building without sophisticated features and provides no air bridges. It uses common departure boarding hall and provide no executive lounges. Terminal 3 currently houses two LCCs, AirAsia and Mandala Airlines for their domestic flights. The total area of Terminal 3 is 30,000 m$^2$. With a 2,231 m$^2$ check-in area, there are around 30 check-in counters provided in the departure area. The commercial area occupies 3,200 m$^2$ and consists of 4 modules. The first floor is used for check-in and commercial activity that can be accessed by all terminal users, including visitors, well-wishers and greeters. The second floor is used for security control, departure lounge hall and commercial area that is restricted to passengers with boarding pass.

5.1 Data Sources and Assumption

Due to data availability, this study merely discusses the major commercial setting required by most passengers and the concessions that provided the main non-aviation revenue at Terminal 3. The data are collected accordingly based on interviews and on-site observations taken on period
of September 2010. Here is the list of the parameters that are obtained through the interviews and observations:

- Concession fee per square meter ($C_{ijk}$) and revenue concession charging ratio ($F_i$) are obtained from Terminal 3 authority through an interview. There are slight differences between concession fees per square meter for departure landside and airside.
- Average spaces required per passenger in every concession ($A_{Si}$) are obtained from interview with concessionaires and also from Hsu & Chao (2005).
- Available maximum spaces for concession ($A_{jk}$) in departure airside and landside are obtained from terminal map documents.
- Minimum spaces required to satisfy basic passengers demand ($S_{ij}$) in departure airside and landside is calculated based on FAA Terminal Space Design Standard cited in Edwards (2005) that is 2.1 m$^2$ per peak-hour passengers.
- Minimum time spent in each concession to make a purchase ($TO_i$) is obtained from direct observation in several concessions.
- Average consumption in each concession ($AC_{ijk}$) is obtained from the average data of 2009 sales revenue report of several concessions.
- This study uses passenger volume ($P_f$) according to the flight schedule of AirAsia and Mandala Airlines that are published in airlines’ websites.
- Well-wishers represent 20% ($r$) of departure passengers, based on interview with Terminal 3 Authority.

Passenger and well-wisher preferences ($e_v$ and $w_{ik}$) toward concession are obtained through an online survey. All the respondents are the previous users of Terminal 3 and they are asked to rank their preferences from the most preferable to the least preferable concessions in departure airside and landside, respectively. To simplify the model, several assumptions are applied in the case study:

(1) The location of commercial area both in departure landside and airside is simplified into three ranges, which are: less than 10 m, 10 – 50 m, and over 50 m. This study assumes that passengers use the shortest walking distance in undertaking every activity.

(2) Based on observation result, shortest time required for undertaking commercial activity $i$ ($TO_i$) is varied based on passenger dwelling time. The longer dwelling time owned by passengers, the longer it takes for them to make a purchase in concession. For departure airside, the $TO_i$ is differed based on three ranges of dwelling time, which are: over 80 min, 40 – 80 min, and less than 40 min. For departure landside, the $TO_i$ is also differed based on three ranges of dwelling time, which are: over 30 min, 15 – 30 min and less than 15 min.

(3) The concessions discussed in this case study are limited to food and beverage concession, travel convenience store, specialized store. There is no duty-free store in Terminal 3 since it only serves domestic flight.
(4) Passenger dwelling time pattern is assumed to be indifferent to time of the day. Passenger dwelling time pattern of AirAsia’s and Mandala’s passengers are observed and stated in probabilistic distribution function. The observation was taken place in check-in hall. Observed passengers are required to write down their arrival time, check-in time and flight boarding time, respectively.

(5) The potential contribution of arrival passengers into concession is not taken into account even though arrival passengers also have access to the commercial area in the first floor of Terminal 3. Arrival passengers are assumed to be contributing less than departure passengers in concession area since their concern is for their baggage and often they need to leave from airport as soon as possible.

5.2 Passenger Demography and Concession Preference

Online questionnaire survey is conducted to reveal the passenger demography, passenger and well-wisher preferences. Well-wishers are the people who accompany passengers to the airport. The primary reason of using web-based survey is the time efficiency. Offering the survey by means of the internet can increase response rates over the survey offered only to those respondents who can be recruited in person (TCRP, 2006).

The total number of collected data is 296, with 222 of them are passengers and 74 of them are well-wishers. The passenger demography survey result is aligned with previous researches about LCC passenger demography by Sabar (2009) and Hanaoka et al. (2009). Most of the passengers are using LCCs for pleasure/personal-related matters (84%) than for business or job-related matters (16%). The dominant passenger’s monthly income is those who have monthly income IDR 2 – 4 millions. About 86% passengers are aged between 21 – 30 years old.

![Travel Purpose](image1.png)

![Airlines](image2.png)

**Figure 1 and 2. LCC passenger demography – Travel Purpose, Airlines**
Figure 3 and 4. LCC passenger demography – Age, Monthly income

Figure 5. Terminal user preferences toward concessions

Note. FB refers to food and beverage concession, CS refers to convenience store, and SS refers to specialized stores

5.3 Passenger Dwelling Time

Dwelling time is critical in the estimation of passenger volume variation in all parts of terminal, including passenger volume variation in concessions. Terminal dwelling time is influenced by terminal access time length and the reliability of an airport’s access system (Kim et al., 2004). It may cause passengers to leave their home or office earlier, so as not to miss a flight. The compulsory process, such as security control and check-in, is another factor that affects dwelling time. In general, long-haul international flights require more time for checking-in and proceed to
security control. It is not unusual for airlines to demand international passengers arrive at the airport 2 – 3 hours before their scheduled departure time.

![Figure 6. Landside and airside dwell time](image)

The standard check-in duration for domestic flight is 4 minutes and it is 5 minutes for security checking process. Beta distribution is found as the most fitted probability density function for passenger dwelling times in Terminal 3. The probability density function of a beta distribution is 

\[ P(t) = \frac{1}{B(\alpha, \beta)} t^{\alpha-1} (1 - t)^{\beta - 1} \]

where \( \alpha \) and \( \beta \) are the two positive shape parameters. The distribution is skewed to the right, denotes that more LCC passengers tend to come earlier to the terminal. One of the reasons for this trend is because there is no prior seating arrangement for LCC passengers. Those who come earlier to terminal will have opportunity to choose good seats. At average, AirAsia and Mandala Airlines passengers comes 1.5 - 2 minutes after the check-in counter open. The mean of dwelling time in airside is 66 minutes for AirAsia passengers and 63 minutes for Mandala Airlines passengers.

<table>
<thead>
<tr>
<th>Airlines</th>
<th>Dwelling time in area</th>
<th>Fitted PDF</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>AirAsia</td>
<td>Airside</td>
<td>Beta distribution</td>
<td>( \alpha = 3.351, \beta = 1.6404, \text{ Min } = -0.495, \text{ Max } = 99.18 )</td>
</tr>
<tr>
<td></td>
<td>Landside</td>
<td>Beta distribution</td>
<td>( \alpha = 2.289, \beta = 1.3113, \text{ Min } = 6.966, \text{ Max } = 96.172 )</td>
</tr>
<tr>
<td>Mandala Airline</td>
<td>Airside</td>
<td>Beta distribution</td>
<td>( \alpha = 2.148, \beta = 1.2619, \text{ Min } = -63.724, \text{ Max } = 35.02 )</td>
</tr>
<tr>
<td></td>
<td>Landside</td>
<td>Beta distribution</td>
<td>( \alpha = 2.294, \beta = 1.359, \text{ Min } = -64.631, \text{ Max } = 35.055 )</td>
</tr>
</tbody>
</table>

### 5.4 Space Allocation Results

This study applies the models formulated in previous section to allocate spaces and positions for concessions in Terminal 3. Passenger stated preference and passenger dwelling time explained in the previous section are incorporated into the model. Table 4 shows the model results for concession space allocation in departure airside and landside. Under current commercial strategy of airside and landside split, the terminal has relatively unbalanced arrangement. There are 136 m² (8.09%) differences between the space demand and the available commercial space in airside,
while there are 946 m$^2$ (62.2%) differences between space demand and capacity in landside. The current concession space utilized/rented in the Terminal 3 is 659 m$^2$ for the landside area (+15% from space demand) and 878 m$^2$ for the airside (-47% from space demand). The lack of shops in the airside area does not support optimally the potential business opportunity from the passengers.

Terminal 3 authority intends to attract other terminal users beside passengers (visitors, well-wishers and greeters) to visit and consume in concessions; they put quite large area in departure landside. However, in Terminal 3, the ratio of well-wishers to passengers is quite low ($r = 0.2$). This ratio is reasonable since Terminal 3 serves domestic short-haul flights. The trip taken by passenger is usually within short period both for leisure and business purpose; therefore passengers tend to come alone without companion from family/well-wishers. The commercial strategy applied in Terminal 3 does not suit its nature as a domestic terminal, resulted in unbalance space allocation.

<table>
<thead>
<tr>
<th>Concessions (i)</th>
<th>Space demand airside (m$^2$)</th>
<th>Allocated space (m$^2$) at departure airside</th>
<th>Space demand landside (m$^2$)</th>
<th>Allocated space (m$^2$) at departure landside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 10 m</td>
<td>10 - 50 m</td>
<td>&gt; 50 m</td>
<td>&lt; 10 m</td>
</tr>
<tr>
<td>Food and Beverage</td>
<td>690</td>
<td>220</td>
<td>470</td>
<td>360</td>
</tr>
<tr>
<td>Travel Convenience</td>
<td>624</td>
<td>0</td>
<td>0</td>
<td>145</td>
</tr>
<tr>
<td>Specialized Store</td>
<td>230</td>
<td>0</td>
<td>170</td>
<td>69</td>
</tr>
<tr>
<td>Total space demand</td>
<td>1544</td>
<td>220</td>
<td>640</td>
<td>574</td>
</tr>
<tr>
<td>Capacity</td>
<td>1680</td>
<td>220</td>
<td>640</td>
<td>1520</td>
</tr>
<tr>
<td>Current utilized area</td>
<td>878</td>
<td>220</td>
<td>640</td>
<td>659</td>
</tr>
</tbody>
</table>

According to the model result, the largest space should be allocated for food and beverage concession to satisfy the potential demand for terminal users in airside (690 m$^2$) and landside (360 m$^2$). The second largest space should be allocated for travel convenience store and then followed by specialized store. Food and beverage concession should be located in the nearest possible location so it is easily accessed by terminal users. Food and beverage concession is counted as the most preferable concessions. Average consumption per person in food and beverage concession is in fact 20.8% lower than average consumption in specialized store. Graham (2008) affirmed that food and beverage concession is used by more passengers but does not produce such high profit margins or revenues (e.g. penetration rates >40% for food and beverages, around 30% for duty-free stores and news/gift stores, specialty retail 25% and bureau
de change less than 10% - Airport Retail Study as cited in Graham, 2008). However, in LCT where there are fewer choices of concessions with high number of potential customers, food and beverage can be counted as the concession that contributes the highest revenue, simply outranks revenues generated by other concessions. Meanwhile, travel convenience store contributes less revenue compared to the other concessions. Travel convenience store is found more attractive than specialized stores, yet its average sales is far lower than what potentially generated by specialized stores. As a result, the model allocates travel convenience store in the least accessible location. The model suggests an idea that is similar with what Hsu and Chao (2005) has stated: the stores with highest potential revenue should be allocated in the more accessible positions with higher passenger flow.

Table 5 shows the revenue generated by each concession in departure airside and landside area, respectively. The revenue is obtained from the rental fee per square meter and also from sales charge ratio (actual buying percentage in airside in 78% and actual buying percentage in landside is 63%). Higher number of potential buyers and higher concession fee per square meter in airside area are the reasons why revenue in departure airside surpasses revenue generated in landside. We attempted to compare the estimation of potential revenue with the current revenue obtained by the terminal, however data limitation prevent us from performing the comparison.

Table 5. Concession potential revenue in airside and landside

<table>
<thead>
<tr>
<th>Concessions</th>
<th>Departure Airside</th>
<th>Departure Landside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Beverage</td>
<td>IDR 241,918,359 (USD 26,710.66)</td>
<td>IDR 142,349,932 (USD 15,717.12)</td>
</tr>
<tr>
<td>Travel Convenience Store</td>
<td>IDR 124,722,415 (USD 13,770.83)</td>
<td>IDR 36,385,223 (USD 4,017.36)</td>
</tr>
<tr>
<td>Specialized Store</td>
<td>IDR 186,268,931 (USD 20,566.30)</td>
<td>IDR 46,643,228 (USD 5,149.97)</td>
</tr>
</tbody>
</table>

Note. 1 USD ≅ 9009 IDR

The result of this study is specific for the Terminal 3. If the methodology is being applied to another terminal, the result may differ from the one shown in this study. However, the methodology pertain generally for commercial space allocation in airport terminal and can be applied (with minor modification) for another case study.

5.5 Airside and Landside Split

One major factor that determines the amount of retail revenue for the airport is the split of available retail space into airside and landside facilities (Parappallil, 2007). Airside refers to the area of the airport that is beyond the passport control that is only accessible to a departing/arriving passenger with a valid ticket. On the other hand, landside refers to the area before the passport control posing no entry barrier to passengers and visitors alike. To a large
extent, this split into airside and landside is pre-determined by airport commercial strategy that reflects which consumer group it intends to target. The commercial strategy has to consider people distribution (passenger and non-passenger) in terminal.

5.5.1 Airside and Landside Split in Existing LCTs

LCCT KLIA, the concession authority, sees a business opportunity from well-wishers and greeters who come along to the terminal so they placed large public concourse area near check-in desks where passengers and non-passengers can enjoy varieties of catering and shops. However, sales generated from LCCT are still lower than the other terminals in the airport.

Table 6. Commercial Space Allocation in LCCT KLIA

<table>
<thead>
<tr>
<th>Location</th>
<th>Floor area (m²)</th>
<th>Retail and F&amp;B outlets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Concourse</td>
<td>660</td>
<td>LCCT Emporium, McDonald's, Asian Kitchen</td>
</tr>
<tr>
<td>Domestic Departure</td>
<td>330</td>
<td>Airport Emporium, Pharmacy, Carlo Rino, Buy &amp; Fly</td>
</tr>
<tr>
<td>International Departure</td>
<td>249</td>
<td>Eraman Duty-free, Pusrawi Pharmacy, Café Espresso</td>
</tr>
<tr>
<td>Domestic Arrival</td>
<td>120</td>
<td>Coffee Bean &amp; Tea Leaf</td>
</tr>
<tr>
<td>International Arrival</td>
<td>108</td>
<td>Eraman Duty-free</td>
</tr>
</tbody>
</table>

Source: Sabar (2009)

Table 7. Comparison of Sales Data in KLIA (LCCT vs. Non-LCCT)

<table>
<thead>
<tr>
<th>Terminals</th>
<th>Jan - Sept 2010</th>
<th>Jan - Sept 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sales (Million)</td>
<td>No of Passengers (Million)</td>
</tr>
<tr>
<td>Total KLIA (Excl. LCCT)</td>
<td>500.1</td>
<td>13.8</td>
</tr>
<tr>
<td>Total LCCT</td>
<td>236.8</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Source: 3rd Quarter Result 2010 MAHB Analyst Slide

Nevertheless, this condition is different from most LCTs that concentrate their concessions area in departure airside; one of the examples is Terminal 5 in JFK. About 90% of the concession in departure area of Terminal 5 is located in airside part. There are only two stores in departure landside, one food and beverage outlet and one newsstand, while in the departure airside there are about 43 stores that consist of food and beverage, specialty retail and newstand. The varieties of food and beverage outlets in Terminal 5 JFK are more sophisticated compared to other LCTs. There are many sit-down restaurants that tend to request more time for passengers to undertake, but there are also some fast budget meals that apply grab-and-go manner. There are over 200 self-serve touch-screen ordering stations throughout the hold room which allows customers to order meals, snacks and beverages using a credit card swipe. This unique concession system has lured passengers to spend more in the concessions. Sales per enplaned passengers in Terminal 5 are higher than the other terminal (Figure 7) with $4.20/enplaned
passenger for retail and $7.83/enplaned passenger for food and beverage. This is a significant prove to the statement in Graham (2009) that the budget airline passengers do not necessarily become budget shoppers in the airport.

![Concessions Performance Comparison by Terminal](image)

**Figure 7. Concessions performance comparison by terminal**

Source: Smith (2009) in Airport Revenue News

### 5.5.2 Sensitivity Analysis

We conduct sensitivity analysis to observe how the revenue is influenced by the changes in commercial space available in departure area. Notify that the total space demand for airside is 1,544 m² and space demand for landside is 575 m² for all concessions (Table 4). When the available space less than the standard demand, the revenue is potentially decreased. When the available space in landside area is reduced 9.8% from the demand (518 m²), the revenue is potentially decreased around 15.04%. When the available space in airside area is reduced 10.5% from the demand, the revenue is potentially decreased around 13.3%. On the other hand, when the space is increased the revenue is not necessarily increase. The current utilized/rented concession space is 659 m² for landside and 878 m² for airside, so only 43.4% and 47.7% are utilized for concession in landside and airside, respectively.

Sales from the airside still accounts for greater amount of retail revenue. Landside revenue only reaches half of what is generated from airside. Furthermore, if there is too much landside shopping, passengers may spend too much time in this area which can reduce their purchases in the airside area, where average spends tends to be higher (Graham, 2008).

The split between airside and landside varies significantly. For Terminal 3 which serves domestic flights, the ideal airside – landside split in departure area is 72.9% – 27.1%. From the available space, only 43.4% and 47.7% are currently utilized for concessions. According to The Moodie Report (2007), on average, 55% of retail space is in the departure airside area and a further 34% in the departure landside area. Only 10% is in the arrivals area (3% airside and 7% landside) and 1% outside the terminal. For terminal with low number of non-travelling customers (visitors, well-wishers, greeters), it is suggested to allocate more commercial space for airside.
Table 8. Sensitivity analysis – Changes in available space

<table>
<thead>
<tr>
<th>Airside</th>
<th>Landside</th>
<th>Space Allocation Airside</th>
<th>Space Allocation Landside</th>
<th>Revenue Airside</th>
<th>Revenue Landside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L1</td>
<td>L2</td>
<td>L3</td>
<td>L1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FB</td>
<td>CS</td>
<td>SS</td>
<td>FB</td>
</tr>
<tr>
<td>2,683 (83.8%)</td>
<td>518 (16.2%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>470</td>
</tr>
<tr>
<td>2,625 (82%)</td>
<td>575 (18%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>470</td>
</tr>
<tr>
<td>1,848 (57.8%)</td>
<td>1,352 (42.3%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>470</td>
</tr>
<tr>
<td>1,680 (52.5%)</td>
<td>1,520 (47.5%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>470</td>
</tr>
<tr>
<td>1,544 (48.3%)</td>
<td>1,656 (51.7%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>470</td>
</tr>
<tr>
<td>1,512 (47.3%)</td>
<td>1,686 (52.7%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>459</td>
</tr>
<tr>
<td>1,344 (42%)</td>
<td>1,856 (58%)</td>
<td>220</td>
<td>0</td>
<td>0</td>
<td>403</td>
</tr>
</tbody>
</table>

Note. 1 USD ≈ 9009 IDR

Figure 8. Optimal landside - airside split

Optimal landside - airside split (27.1% - 72.9%)
6. Conclusion

This study has proposed a space allocation model for commercial activities at airport’s LCT. We incorporate the nature of low-cost business model, such as LCC passenger dwelling time and preferences toward concessions. Through a case study in Terminal 3 Soekarno-Hatta, the model is validated.

Food and beverage is the most-visited and most-needed concession in LCT for passengers and well-wishers both in airside and landside area. Passengers in airside visit more choices of concessions than passengers in landside; specialized store becomes attractive in the airside area. The demography of LCC passengers is dominated by young people with relatively low income level who use the travel service for leisure purposes. This characteristic becomes one of the factors that influence passenger behavior toward concessions in LCT. The probability distribution shows that LCC passengers tend to come early to the terminal. One of the reasons for this trend is because there is no prior seating arrangement for LCC passengers. Those who come earlier to terminal will have opportunity to choose good seats.

According to the model result, the largest space should be allocated for food and beverage concession to satisfy the potential demand for terminal users in airside and landside. The stores with highest potential revenue should be allocated in the more accessible positions with higher passenger flow.

For our case study, Terminal 3 which serves domestic flights, the ideal airside – landside split in departure area is 72.9% – 27.1. Sales from the airside still accounts for greater amount of retail revenue. For terminal with low number of non-travelling customers (visitors, well-wishers, greeters), it is always better to allocate more commercial space for airside.
REFERENCES


Transit Research Cooperative Program (TRCP), 2006. Web-Based Survey Techniques. Transportation Research Board.