Abstract

Assessing airport service performance requires understanding of a complete set of passenger experiences covering all activities from departures to arrivals. Weight-based indicator models allow passengers to express their priority on certain evaluation criteria (airport domains) and their service attributes over the others. The application of multilevel regression analysis in questionnaire design is expected to overcome limitations of traditional questionnaires, which require application of all indicators with equal weight.

The development of a Taxonomy of Passenger Activities (TOPA), which captures all passenger processing and discretionary activities, has provided a novel perspective in understanding passenger experience in various airport domains. Based on further literature reviews on various service attributes at airport passenger terminals, this paper constitutes questionnaire design to employ a weighting method for all activities from the time passengers enter an airport domain at the departure terminal until leaving the arrival terminal (i.e. seven airport domains for departure, four airport domains during transit, and seven airport domains for arrival). The procedure of multilevel regression analysis is aimed not only at identifying the ranking of each evaluation criterion from the most important to the least important but also to explain the relationship between service attributes in each airport domain and overall service performance.

Airports, Questionnaire design, Passenger experiences, Airport service performance

Airport management needs to know how they could identify some improvement opportunities within airport service area in order to meet or exceed passenger satisfaction with their service performance. Customer satisfaction surveys are collected from population sampling in order to evaluate the service quality based on the customer's point of view.
Although there are various airport performance models based on passenger experience, most research has applied tailored surveys and questionnaire as their data collection method (Wiredja, 2015). Questionnaires have been used to obtain passenger perception on the relative importance of attributes affecting airport performance mostly using five-point Likert-type Scale (measured on a scale from 1 as very unimportant to 5 as very important).

The design of questionnaires for survey research represents one of the most challenging aspects in terms of accuracy in measuring respondents' perception (Sato, 2003). Furthermore, Sato (2003) elaborated that traditional questionnaire using simple multiple-choice format identifies only the most important alternative for each respondent preventing the respondent from expressing his or her preference concerning a selected alternative over the others.

Weight-based indicator models define airport performance as a function translating passenger responses and incorporating the importance of every component (and its attributes) over the others based on passenger experience at all airport areas. The application of weighting method in a passenger experience survey refers to the choice of customer when evaluating a product or service based on several components and attributes. Unlike some airport models assuming each evaluation criterion has equal important weight, the weight-based indicator models allow customer to express their priority on certain evaluation criteria over the others. Passengers are given opportunity to indicate all components (airport domains) and their characteristics (attributes) from the most important ones to the least important one. Knowing that each airport domain (i.e. car park, check-in, immigration, departure lounge, and retail area among others) has a different nature of operation, passengers may have different priority in assessing airport service performance. As an example, passenger can choose waiting time as the most important attribute for check-in, security as the most important attribute for car park, and the variety of shops as the most important one for concessions or retail area.

Depending on the objectives, scope, and method of the research, every author generally conducts relevant literature review before defining a research framework consisting of a number of factors (or domains) and their attributes. The definition of service factor or airport-domain refers to the specific area of service at airport passenger terminals. In this research, the authors select “airport domain” as the preferred name representing each independent variable in assessing overall service performance based on passenger activities.

Using a larger number of factors results a more detailed set of measurements which is clearer not only for passengers when filling in the questionnaires but also for the airport management when identifying specific area(s) for improvement. Based on research employing weighting method in assessing airport service performance, Wiredja (2015) found that researchers using a larger number of factors have a tendency to use regression analysis instead of a more comprehensive multistage assessment such as Analytical Hierarchy Process (AHP) and Fuzzy Multi-Attribute Decision Making. For instance, when three factors are used (i.e. A, B, C) under the AHP method, there will be three comparisons of the relative importance among factors in its questionnaire (i.e. A to B, A to C, and B to C) while if eight factors are used under the AHP Method, there will be 28 comparisons of the relative importance among factors in its questionnaire, which may confuse respondents when comparing between one factor and the others.
When questionnaires are well tailored and designed, they can be effective tools to encourage most people in the sample to respond with the right interpretation (Dillman, Smyth, & Christian, 2009). Additionally, it is considered an efficient method of determining passenger needs to improve airport performance (Yeh & Kuo, 2003).

In this paper, the authors will highlight the importance of weighting method application, particularly multilevel regression analysis, in assessing airport service performance based on passenger experiences. A clear and systematic structural relationship between airport domains (independent variables) and airport service performance (the dependent variable) is important to determine the questionnaire design.

**Reviews on Airport Passenger Experiences**

Airport passenger experience includes a complete set of passenger activities from departure terminal to arrival terminal in order to meet requirements in all airport processing domains and to spend any spare time they have in these airport terminals.

Popovic, Kraal, and Kirk (2010) described airport passenger experience as “*activities and interactions that passengers undergo in an airport terminal building*”. Passenger experience is categorised into two broad categories: (i) processing activities and (ii) discretionary activities. Processing activities are those that should be completed by a passenger in sequence upon arrival at the airport, which consist of check-in, security screening, immigration, and boarding; while discretionary activities are optional and unordered activities based on passengers’ freedom of choice (Kirk, 2013; Popovic et al., 2010).

Due to the limited research that takes the passenger perspective to measure airports’ performance, the relevant attributes for the above-mentioned airport domains based on passenger activities are important to be explored. The weight given by passengers for every airport domain and its respective attributes could be further formulated to measure airport service performance. This type of weight-based indicator performance model is expected to assess passenger expectations on airport service performance based on deeper understanding of passenger activities.

Measurement of customer satisfaction is an important strategic development instrument in any company and industry, necessary effort is needed to build a performance indicator for customer satisfaction in a rapidly changing environment (Eklof & Westlund, 1998; Walsh, 1999). Since customer needs are changing over time, airports should be able to adjust to these changes by delivering services that customers require. Wiredja (2010) recommended companies use a set of dynamic performance measures that provide flexibility to adjust the measures depending on their needs, adding or replacing measures as the company evolves.

Popovic et al. (2010) classified an airport processing domains in the departure terminal into: (i) check-in, (ii) immigration (iii) security screening, and (iv) boarding, while the processing domains in the arrival terminal consist of (i) disembarkation, (ii) immigration, (iii) baggage claim, and (iv) customs and quarantine. While queuing and processing activities remain important to the experience, what passengers do when they are not being processed is also important. Recent research highlighted that a passenger’s time inside the airport terminal building can be approximately be apportioned as 50% processing and 50% discretionary.
(Fukaya, 2012). Other research found that accounted for approximately two thirds of passengers’ whole airport experience (Kirk, Popovic, Kraal, & Livingstone, 2012). Discretionary activities of air passengers consist of carrying out consumptive, social, passive, preparatory, queuing and entertainment activities during their time at the airport. The classification of passenger activities is important not only to analyse passenger experience but also to improve airport service performance. Moreover, each activity or combination of these activities is important improve airport passenger experience. For instance, when the airport management provided clear information in advance to every passenger (preparatory activities) before queuing at the X-ray machine, this resulted a significant reduction in average queuing times and an increased capacity on screening processing from 260 passengers per hour to 340 per hour (Kirk et al., 2012).

The Taxonomy of Passenger Activities (TOPA) model, which captures all passenger processing and discretionary activities, has provided a novel perspective and detailed understanding of: (i) what passengers do at an airport, (ii) how passengers are processed, (iii) how they spend their discretionary time, and (iv) where the airport can potentially improve passenger experience (Kirk, 2013). Selection of service attributes in assessing airport performance based on passenger experiences will include all types of passenger activities into a complete set of airport domains from the time passengers enter an airport domain at the departure terminal until leaving the arrival terminal. This conceptual framework will be used to design a questionnaire in this research.

To measure passenger satisfaction for these non-processing activities, many researchers use “Airport’s Accessibility” and “Airport’s Facilities” as two domains as they have different evaluation criteria. While “Airport’s Accessibility” relates to the infrastructure support connecting airport and ground transportation experienced by passengers, “Airport’s Facilities” covers a wide range of facilities inside airport terminal building.(Bogicevic, Yang, Bilgihan, & Bujisic, 2013; W. L. Chang, Liu, Wen, & Lin, 2008; Eboli & Mazzulla, 2009; Liou, Tang, Yeh, & Tsai, 2011; Rhoades, Waguespack, & Young, 2000; Tsai, Hsu, & Chou, 2011).

Moreover, some researchers have applied retail area as a significant evaluation criterion to measure passenger satisfaction (Atalik, 2009; Bogicevic et al., 2013; Correia & Wirasinghe, 2013; Correia, Wirasinghe, & Barros, 2008; George, 2013; J.D. Power and Associates, 2010; Kirk, 2013; Liou et al., 2011).

Taking into account the importance of Airport’s Accessibility, Airport’s Facilities, and Retail Area both for departure and arrival terminals, Wiredja (2015) included these three non-processing domains making the composition of airport domains (Figure 1):

1. Departure
   a. Processing domains: Check-in, Security, Immigration & Customs, Boarding
   b. Non-processing domains: Airport’s Accessibility, Airport’s Facilities, Retail Area

2. Arrival
   a. Processing domains: Disembark, Immigration, Baggage Claim, Customs
   b. Non-processing domains: Airport’s Accessibility, Airport’s Facilities, Retail Area
The following sections elaborate the selection of related attributes for eighteen airport domains or components based on passenger-driven experiences consisting of seven airport domains for departures, four airport domains during transit, and seven airport domains for arrivals. Thereafter, TOPA’s eight types of activities will be incorporated into all recommended service attributes to facilitate questionnaire design for airport passenger experience survey.

**Airport Domains at Departure Terminal**

The evaluated processing domains are check-in, security screening, immigration and customs, and boarding. Meanwhile the evaluated non-processing domains are airport’s accessibility, airport’s facilities, and retail area.

The perception of waiting time or queuing time and staff courtesy are two main indicators used by many researchers to measure satisfaction at check-in, security screening, and the immigration domains based on passenger experience (Airport Council International, 2008; Bogicevic et al., 2013; W. L. Chang et al., 2008; Chao, Lin, & Chen, 2013; Tsai et al., 2011; Yeh & Kuo, 2003).

Security screening and the immigration domains are two non-compromised airport domains based on the strict procedures that should be fully complied without any breach to ensure all passengers are secure on their flights. On the other side, many airports aim to deliver their best service to meet passenger satisfaction by conducting an efficient but low-hassle screening and immigration process.

The efficiency of boarding, staff courtesy, and availability of aerobridge are three common indicators applied by many researchers to measure service satisfaction during boarding (Y. C. Chang & Chen, 2012; Rhoades et al., 2000; SKYTRAX, 2014a).

Departure retail area is an essential airport domain where passengers spend their time during most discretionary activities at the departure terminal. Livingstone (2013) defined passenger retail experience as landside and airside retail areas where air passengers do their discretionary activities both before security check point (landside retail area) and after security check point (airside retail area).
Airport Domains at Transit Terminal

Unlike the departure terminal, limited research has been conducted to assess passenger needs during transit. Taking into account that transfer passengers have different needs compared to those of originating and terminating passengers, few researchers have measured the overall satisfaction for transit passengers based on different assessment models: (i) J. W. Park and Jung (2011) used SERVQUAL (an equal-based indicator performance model), (ii) De Barros, Somasundaraswaran, and Wirasinghe (2007) used regression analysis (a weight-based indicator performance model), and (iii) Seyanont (2011) used statistical techniques of factor, regression and Variance Analysis (another weight-based indicator performance model).

While airport facilities and retail areas have been mostly evaluated in assessing airport service performance at the transit terminals, De Barros et al. (2007) found that security screening, an airport processing domain, has the highest impact value contributing to the overall airport performance for transfer passengers due to time consuming, unpleasant, and awkward experiences at this airport domain. Moreover, some airports (e.g. Australian and North America Airports) require transfer passengers with connecting domestic flight to change terminal to do self-service baggage transfer (i.e. collecting their baggage from international terminal and rechecking it again at the domestic terminal). On the other hand, many international hub airports provide automatic baggage transfer for all passengers with international or domestic connecting flights. However, limited research has been conducted to examine the impact of self-service baggage transfer on the overall airport performance.

Based on the passenger activities during transit, a passenger-driven experience model should include relevant attributes for four airport domains at transit terminal: (i) Transit Security Screening (ii) Baggage Transfer, (iii) Airport Facilities and (iv) Retail Area.

Airport Domains at Arrival Terminal

A review of relevant attributes on some airport domains at arrival terminals is important because the current performance models only measure activities for arriving passengers based on simplified attributes as earlier discussed. Few researchers have used common attributes at arrival terminal to measure overall passenger satisfaction based on passenger experience. Some airport domains have been used to measure service satisfaction based on passenger experience at arrival terminal: (i) immigration, (ii) baggage claim, (iii) customs and quarantine, and (iv) airport’s facilities both in landside and airside area (Airport Council International, 2008; Atalik, 2009; Chao et al., 2013; Liou et al., 2011; Lubbe, Doughlas, & Zambellis, 2011; Seyanont, 2011; Yen, Teng, & Chen, 2001).

Meanwhile, there are three airport non-processing domains (disembarkation, retail area, and airport’s accessibility) to adequately represent a set of airport indicators based on passenger activities at the arrival terminal.
Questionnaire Design

An ideal passenger-driven airport model defines the overall service performance as a function of combined sub-performances of a set of airport domains using a weight-based indicator model. Taking into account the difference in nature between processing and non-processing airport domains, passenger activities the airports are grouped into two categories with its respective set of service attributes: (i) a group of processing domains for compulsory activities and (ii) a group of non-processing domains for optional activities.

Service attributes in every airport domain will be used to assess airport service performance based on passenger experience. To fully explore passenger experience, Kirk (2013) applied an activity-centred approach to understand interactions between the humans and the artefact(s) within airport environmental context where all passenger activities take place from the airport entrance (check-in) to their time of departure (boarding). The development of TOPA allows a better understanding of passenger experience and how passenger activities are classified into eight categories: (i) processing, (ii) queuing, (iii) consumptive and (iv) moving, (v) passive, (vi) entertainment, (vii) social and (viii) preparatory (Kirk, 2013).

Kirk (2013) highlighted the importance of each activity or combination of these activities to improve airport passenger experience:

1. Processing activities are considered separately from queuing activities because it is the processing activity group that can improve or impair the passenger experience rather than queuing.

2. Providing passengers with preparatory knowledge (e.g. clear information to fill Outgoing Passenger Card) before immigration check point can improve processing activities.

3. During consumptive activities, passengers spent the greatest amount of time browsing, followed by interacting with airport staff and/or their companions. Both of these activities contribute to reducing the perceived time of passengers at airports.

4. Passengers are focused on moving easily from one processing domain to the next domain. While boarding is the only processing stage remaining, most passengers do their discretionary activities before boarding, such as visiting retail outlets.

5. Airports need to provide quiet areas for passengers who wish to sit quietly with no distractions, thus supporting their passive activities.

6. TOPA illustrates the importance of Wi-Fi to support entertainment activities by revealing the large amount of time passengers spend using their own technology, and documenting the negative comments when Wi-Fi was not available.

7. Layout of some airport domains is currently not designed to support social activities. Social interactions could potentially be sacrificed to reduce processing time such as passengers are expected move straight from security to customs without having social interactions between them.

Moreover, some surveys have another limitation because of the tendency to simplify activities for arrival and transit passengers. For instance, passport inspection for arriving passengers is rated as one attribute (overall satisfaction) while passport inspection for
departing passengers is rated as two attributes: (i) waiting time at passport inspection and (ii) courtesy of inspection staff (Airport Council International, 2008; Kramer, Bothner, & Spiro, 2013). Instead of having only one attribute, the authors identify three possible activities for arriving passengers at passport inspection section: (i) waiting time at passport inspection, (ii) courtesy of inspection staff, and (iii) waiting time to obtain visa on arrival (if required).

Wiredja (2015) found that most authors have focused on departing passengers, taking into account that there is longer waiting time, which is sufficient to fill questionnaires and/or conduct interviews, for departing passengers compared to that for transit and arriving passengers.

Subsequently, the following research methodology is applied in the questionnaire design:

1. To ensure that all service attributes are grouped into two sets of airport domains (i.e. processing and non-processing domains).
2. The survey investigates various criteria to measure each airport domain based on passenger activities in the airport. A closed questionnaire will be designed through an online survey and sent to 400 international air passengers in order to secure the result with 95% of confidence level.
3. To use data from air passenger survey to populate model parameters and its structure This is to determine boundaries for positive and negative satisfaction and performance targets or benchmarks (Chao et al., 2013; Correia et al., 2008; Liou et al., 2011; Y. H. Park, 1999; Yeh & Kuo, 2003).

In this research, activities start from the time passengers enter an airport’s processing domain at the departure terminal, waiting in the transit terminal, until leaving the arrival terminal. TOPA’s eight types of activities will be applied to a complete set of service attributes in each airport domain based on passenger activities starting from departure, transit, to arrival including passenger activities during transit. For instance, the authors identify three possible activities from various types for arriving passengers at Customs and Quarantine section: (i) waiting time (queuing activity), (ii) courtesy of staff (processing activity), and (iii) clear information on customs declaration (preparatory activity). When air passengers evaluate the degree of importance of each three service attributes at Customs and Quarantine domain, the data could be used not only to determine the parameters for its structural relationship between service attributes and service performance but also to facilitate proper analyses on how the importance of each activity could improve passenger experience.

Based on the review of a complete set of airport domains, their characteristics and types of passenger activities, a summary of relevant attributes for all airport domains based on passenger experience is presented in Table 1.
<table>
<thead>
<tr>
<th>No</th>
<th>Airport Domains (10) and their Attributes (26)</th>
<th>Activity Type</th>
<th>Attributes (Criteria)</th>
<th>No</th>
<th>Airport Domains (8) and their Attributes (33)</th>
<th>Activity Type</th>
<th>Attributes (Criteria)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Check-in</td>
<td>Queuing</td>
<td>(i) Perception of waiting time or queue length</td>
<td>1</td>
<td>Airport’s Accessibility (Departure &amp; Arrival)</td>
<td>Moving</td>
<td>(i) Options of ground transportation (D,A)</td>
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<td></td>
<td></td>
<td></td>
<td>(ii) Staff courtesy or helpfulness</td>
<td></td>
<td></td>
<td></td>
<td>(iii) Availability of parking facilities (D) or</td>
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<td></td>
<td></td>
<td></td>
<td>(iii) Check-in efficiency</td>
<td></td>
<td></td>
<td></td>
<td>Perception of queue length for regular taxi (A)</td>
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<tr>
<td>2</td>
<td>Security Screening</td>
<td>Processing</td>
<td>(i) Staff courtesy</td>
<td>2</td>
<td>Airports’ Facilities (Departure, Transit, Arrival)</td>
<td>Consumptive</td>
<td>(i) Availability of ATM or money changer (D,T,A)</td>
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<td></td>
<td></td>
<td></td>
<td>(ii) Secure feeling/thoroughness</td>
<td></td>
<td></td>
<td></td>
<td>(ii) Sanitary condition of restrooms (D,T,A)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(iii) Perception of waiting time or queue length</td>
<td></td>
<td></td>
<td></td>
<td>(iii) Comfort of waiting area / lounge (D,T)</td>
</tr>
<tr>
<td>3</td>
<td>Immigration and Customs</td>
<td>Queuing</td>
<td>(i) Perception of waiting time</td>
<td>3</td>
<td>Retail Area (Departure, Transit, Arrival)</td>
<td>Consumptive</td>
<td>(i) Variety of shops (D,T,A)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(ii) Staff courtesy</td>
<td></td>
<td></td>
<td></td>
<td>(ii) Value for money of shops and cafe (D,T,A)</td>
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<td></td>
<td></td>
<td></td>
<td>(iii) Perception of waiting time or queue length</td>
<td></td>
<td></td>
<td></td>
<td>(iii) Variety of foods and beverages (D,T,A)</td>
</tr>
<tr>
<td>4</td>
<td>Boarding</td>
<td>Processing</td>
<td>(i) Efficiency of boarding procedure</td>
<td>4</td>
<td></td>
<td>Moving</td>
<td>(iv) Perception of shopping facilities (D,T)</td>
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<td></td>
<td></td>
<td></td>
<td>(ii) Staff courtesy</td>
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<td></td>
<td></td>
<td></td>
<td>(iii) Availability of aerobridge</td>
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<tr>
<td>5</td>
<td>Transit Screening</td>
<td>Processing</td>
<td>(i) Staff courtesy</td>
<td>5</td>
<td></td>
<td>Consumptive</td>
<td>(i) Variety of shops (D,T,A)</td>
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<td></td>
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<td></td>
<td>(ii) Secure feeling/thoroughness</td>
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<td>(ii) Value for money of shops and cafe (D,T,A)</td>
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<td>(iii) Perception of waiting time or queue length</td>
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<td></td>
<td>(iii) Variety of foods and beverages (D,T,A)</td>
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<tr>
<td>6</td>
<td>Baggage Transfer</td>
<td>Processing</td>
<td>(i) Availability of automatic baggage handling</td>
<td>6</td>
<td></td>
<td>Consumptive</td>
<td>(iv) Perception of shopping facilities (D,T)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(ii) Secured Baggage</td>
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<tr>
<td>7</td>
<td>Disembarkation</td>
<td>Processing</td>
<td>(i) Availability of aerobridge</td>
<td>7</td>
<td></td>
<td>Consumptive</td>
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<td></td>
<td></td>
<td></td>
<td>(ii) The ease of wayout finding</td>
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<tr>
<td>8</td>
<td>Arrival Immigration</td>
<td>Queuing</td>
<td>(i) Perception of waiting time on immigration</td>
<td>8</td>
<td></td>
<td>Consumptive</td>
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<td></td>
<td></td>
<td></td>
<td>(ii) Staff courtesy</td>
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<td></td>
<td>(iii) Perception of waiting time on visa on arrival</td>
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<tr>
<td>9</td>
<td>Baggage Claim</td>
<td>Queuing</td>
<td>(i) Perception of baggage delivery time</td>
<td>9</td>
<td></td>
<td>Consumptive</td>
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<td></td>
<td></td>
<td></td>
<td>(ii) Secured baggage delivery</td>
<td></td>
<td></td>
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<tr>
<td>10</td>
<td>Customs and Quarantine</td>
<td>Queuing</td>
<td>(i) Perception of waiting time or queue length</td>
<td>10</td>
<td></td>
<td>Consumptive</td>
<td></td>
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<td></td>
<td></td>
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<td>(ii) Staff courtesy</td>
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<td></td>
<td></td>
<td></td>
<td>(iii) Clear information of customs declaration</td>
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</tbody>
</table>
Multilevel Regression Analysis

To determine the impact of each airport domain on airport service performance, a structural equation model could formulate the weight given by passengers for every airport domain (based on the average score of importance from its respective attributes) in order to measure the overall airport service performance. The use of average score is dynamic enough to incorporate a new attribute or to adjust a current attribute in any airport domain.

Regression analysis is a flexible statistical modelling technique to determine an equation explaining the mathematical relation between one dependent variable and at least one independent variable (Blank, 1982). Because ordinal regression analysis is linear in nature between dependent and independent variables, this technique is adopted to estimate the weight of service attributes (independent variables) in order to measure the overall passenger satisfaction (dependent variable) (Eboli & Mazzulla, 2009).

The structural equation is developed linearly using regression method where overall airport performance is defined as the dependent variable (Y). The method of regression function estimates all possibilities incorporating pre-set values (weights) of a set of dependent variables (Xi) where i is the counting number of the explanatory variables. The pre-set value in each dependent variable represents the importance weight given by respondents. In this study, respondents will be asked to indicate the perceived importance of each airport domain and its characteristics from the most important to the least important by using a five-point Likert-type Scale. Each respondent is requested to fill the degree of importance (i.e. how important each airport domain to him or her) in assessing airport service performance based on a full set of passenger activities at departure, transit, and arrival terminals. There are two parts of the survey in evaluating the degree of importance based on two groups of airport domains:

(i) Airport processing domains (based on compulsory passenger activities)
(ii) Airport non-processing domains (based on discretionary passenger activities)

Therefore, the overall airport performance (Y) is modeled as combined sub performances of a group of airport processing domains (X1) and a group of airport non-processing domains (X2). When a straight-line relation is assumed to be the best between X and Y, the general mathematical model for X1 and X2 is

\[ Y = \alpha + \beta_1 X_1 + \beta_2 X_2 \]

Where \( \alpha \) value is the constant parameter and each \( \beta \) value is coefficient parameter for each dependent (explanatory) variable.

Knowing that combined sub-performances of two groups of airport domains are determined by passenger activities at three travel stages – Departure, Transfer, and Arrivals – with a set of service attributes, a multilevel structural relationship is presented (Figure 2).
For instance, the sub-performance of $P_1$ (a group of airport processing domains) is determined by three parts of sub-performance of Departure ($D_1$), Transit ($T_1$) and Arrival ($A_1$) while the sub-performance of $P_2$ (a group of airport non-processing domains) is determined by three parts of sub-performance of Departure ($D_2$), Transit ($T_2$) and Arrival ($A_2$). The lowest level performance in each area ($D_1$, $D_2$, $T_1$, $T_2$, $A_1$, and $A_2$) is shaped by every single airport domain in each travel stage. For example, departure sub-performance at processing domains ($D_1$) is determined by the perception result of Check-in ($C_1$), Security ($S_1$), Immigration ($I_1$), and Boarding ($B_1$).

To determine the impact of each airport domain on airport service performance, an ordinal logistic regression model will be formulated based on the weight (i.e. the average score of its respective attributes) given by passengers for every airport processing-domain. Similarly, the ordinal logistic regression model will also be formulated based on the weight given by passengers for every airport non-processing domain.

The test of multicollinearity will be conducted to ensure that the independent variables in the model are not linearly related. This is also to maintain the reliability of the structural relationship in the model consisting of the relative importance of airport domains (the independent variables) in assessing service performance (the dependent variables). If a multicollinearity effect is found, related procedures will be performed accordingly to eliminate such multicollinearity in the model.

Based on this design, every result of the lower level will become an explanatory variable to the regression model at a higher level in order to determine the overall airport performance ($Y$) at the first level of analysis.
Consequently, the questionnaire design is expected to have two groups of airport domains:

a) Airport processing domains (based on compulsory passenger activities)
b) Airport non-processing domains (based on discretionary passenger activities)

Each respondent will be requested to fill the degree of importance (i.e. how important each airport domain to them) based on a scale from 1 (very unimportant), 2 (unimportant), 3 (neutral), 4 (important), or 5 (very important) in assessing airport service performance. Each group of airport domains is evaluated based on passenger activities at three travel stages – Departure, Transfer, and Arrivals.

For instance, the group of airport processing domains consists of departure, transfer, and arrival. Within departure stage, there are four airport domains: (i) Check-in, (ii) Security Screening, (iii) Immigration and Customs, and (iv) Boarding. Each airport domain and its respective service attributes (Table 1) is evaluated using a five-point Likert-type scale in the questionnaire design. As shown in Table 3, the impact of check-in on overall service performance is evaluated based on the average score of importance given by passengers for three service attributes: (i) queuing time, (ii) staff courtesy, and (iii) check-in efficiency. The same approach also applies for three other airport domains (i.e. Security Screening, Immigration and Customs, and Boarding) for departure stage. Subsequently, Table 3 describes how each airport processing domain within departure stage is evaluated based on passenger perception of the degree of importance using selected service attributes (previously shown in Table 1).

Table 3. Questionnaire Design for Departure at the group of airport processing Domains

<table>
<thead>
<tr>
<th>DEPARTURE</th>
<th>I. Check-in</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Waiting in line for check-in should not be more than 15 (fifteen) minutes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Check-in staff are helpful and courteous.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Check-in process is efficient and/or easy for you.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>II. Security Screening</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Security staff are helpful and courteous.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>You feel secure after a thorough screening.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Waiting in line for security screening should not be more than 15 (fifteen) minutes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>III. Immigration and Customs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Immigration and Customs staff are helpful and courteous.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Waiting in line for immigration clearance should not be more than 15 (fifteen) minutes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>IV. Boarding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Boarding procedure is efficient and/or easy for you.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Boarding staff are helpful and courteous.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11</td>
<td>The use of aerobridge makes easier and safe connection between airport terminal and aircraft.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Implications for Airport Service Design

It is expected that the result of this survey will be to formulate the structural relationship between airport domains (independent variables) and airport service performance (the
dependent variable). More specifically, the linear regression equations will formulate the relationships between independent and dependent variables at three levels of analysis:

1. The first level: between each group of airport domains and the overall performance.
2. The second level: between travel stages (i.e. Departures, Transfer, and Arrivals) and each group of airport domains (i.e. processing and non-processing).
3. The third level: between each airport domain and each travel stage.

This research is projected to have positive implications for airport service design, as follows:

1. To improve existing airport performance models as the perceived outcome of the questionnaire could facilitate the identification of passenger-driven indicators in assessing airport service performance.
2. To enhance current methodology in assessing airport service performance by employing weighting method on a complete set of airport domains and their respective attributes from the time passengers enter an airport domain at the departure terminal until leaving the arrival terminal.
3. The role of airline passengers as a major airport’s stakeholders will be clearly expressed in the identification of passenger-centred indicators.

**Conclusion**

The specifically designed questionnaire could facilitate the examination of the structural relationship between airport domains and overall service performance. It is recommended to apply multilevel regression analysis defining overall service performance as a function of combined sub-performances of two groups of airport domains with a set of relevant attributes: (i) processing domains and (ii) non-processing domains. The incorporation of TOPA’s eight types of activities to all service attributes will enhance the formulation of passenger-centred indicators in assessing airport service performance.

To deepen the results from survey analysis on the application of a weight-based indicator model in assessing airport service performance, it is recommended to also examine the impact of passenger profile characteristics (i.e. regular flyers, frequent flyers, passengers with special needs, passengers with airport experience) on the said relationship. For example, passengers with special needs may have different priorities compared to business class or premium passengers in identifying airport passenger-centred indicators.

Using the right questionnaire design, the three-level of linear regression analysis will be able to examine the impact of a complete set of service attributes (i.e. seven airport domains for departure, four airport domains during transit, and seven airport domains for arrival) towards airport service performance. Some related statistical tools like factor analysis and test of multicollinearity are proposed to complement the application of multilevel regression analysis. This is to eliminate some overlapping effects among the independent variables towards the dependent variables in order to maintain the reliability of the structural relationship in the model.
References


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Author Biographies

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Dedy Wiredja is a PhD Candidate within School of Design at Queensland University of Technology in Brisbane, Australia. Having obtained his Master’s degree from Monash University in Melbourne, Dedy has spent his twelve years’ professional experience taking various roles in financial and performance management in Singapore and Jakarta (Indonesia). He had been invited to several United Nations’ international conferences during his service at Jakarta-based political and economic organisation of ten Southeast Asian Countries. Continuing his journey, Dedy sharpens his gears into performance and service design. His current research draws on this rich background and aims to improve existing
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Vesna Popovic (PhD) is a Professor in Industrial Design at Queensland University of Technology, Brisbane, Australia. Her research focus is within experience and expertise, intuitive interaction and intuitive navigation domains. She has made an international contribution to design research where she has integrated knowledge from other related areas and applied to the artifact design (e.g. human factors/ergonomics, product usability, design and cognition, expertise and experience) in order to support and construct design applications. In particular, she has been a founder and Director of People and Systems Lab domain at QUT. The impacts of Vesna’s research lies in the cross-fertilisation of knowledge across humanities and technologies to design humanised artifacts/ systems by facilitating the understanding of diverse expertise and experience. Vesna is a Fellow of the Design Research Society (UK) and Design Institute of Australia (DIA). Professor Vesna Popovic is the recipient of four Australia Research Council grants (v.popovic@qut.edu.au).

Alethea Blackler

Alethea Blackler (PhD) is an Associate Professor and Head of Discipline in Industrial Design at Queensland University of Technology, Brisbane, Australia. Her principle area of research interest is intuitive interaction, in which she is one of the world leaders. She pioneered the first empirical work in the field, and has led a prestigious ARC Discovery project on Facilitating Intuitive Interaction for Older People. She recently edited a special issue of the OUP journal Interacting with Computers on Intuitive Interaction and is continuing work on developing design methodology for intuitive interaction as well as applying intuitive interaction into other areas, such as gaming, children, navigation and expertise. She has published extensively, been invited to give presentations internationally and is the recipient of several awards. She has regularly reviewed papers for international conferences and journals and is long papers co-chair for IASDR2015. Associate Professor Blackler is a member of the Design Research Society (DRS) (a.blackler@qut.edu.au).

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