Trip Attraction, Trip Distribution, and Modal Split for Columbarium Trips

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Abstract: Grave-sweeping is a popular special event in Asia, especially in Chinese societies, in which families visit columbaria to express filial piety to their ancestors. The extraordinarily high travel demands usually associated with visiting columbaria during a relative short period around the grave-sweeping festivals severely affect the local traffic. To design and plan adequate transport facilities and services to cater to the travel needs of these families, modeling of their travel demand is a prerequisite procedure. This paper develops and calibrates a non-linear regression model for trip attraction and a joint logit model for trip distribution and modal split using data from headcount and revealed preference surveys collected at selected columbaria during the Ching Ming Festivals of 2013 and 2014. This paper also discusses policy insights gained from the model results that can be applied to the planning of transport facilities and the provision of feeder services to mitigate local congestion during the festivals.

Keywords: Travel Demand Modeling, Special Events, Columbarium Trips, Non-linear Regression Model, Joint Logit Model

1. INTRODUCTION

Grave-sweeping is a popular special event in Asia, especially in Chinese societies (e.g., in Hong Kong), in which families express filial piety to their ancestors during two traditional grave-sweeping festivals, the Ching Ming Festival in early-April and the Chung Yeung Festival in mid-October every year. In most cases, the remains of the ancestors are either buried in graves at cemeteries or entombed in niches at columbaria. No new large-scale cemetery has been developed in Hong Kong since 1976 because graves occupy more space and the land supply is severely limited (Civil Service Bureau, 2006). In recent decades, the government has developed numerous columbaria at many locations, the majority of them built as multi-storey buildings with high niche density. Although this met the demand for entombing ancestors, the columbaria more severely affect local traffic than do cemeteries because of their high niche density. Many visitors go to columbaria for grave-sweeping on the festival dates and the neighboring weekends (including Saturday and Sunday), and the number of visitors often exceeds the handling capacities of the transport facilities and services provided, thus causing traffic congestion. Many objections are often received during the consultation period for new columbarium developments from local residents, who are simply asking to minimize the disturbance to their daily lives. Nevertheless, studying the travel demand patterns of columbarium visitors is important and necessary for better transport planning and traffic management to achieve this goal.
Travel demand modeling is a prerequisite procedure in understanding how people distribute over time, locations, and transport modes. The development of the concept of travel demand modeling can be traced back to the mid-nineteenth century (Sivakumar, 2007). Travel demand has been commonly modeled when planning transport facilities and services that respond to the demand (e.g., Espino et al., 2007; Bhatta and Larsen, 2011; Batarce and Ivaldi, 2014). Inadequate transport provision leads to congestion and was found to be particularly severe for special events (e.g., conferences and exhibitions, concerts, football matches, and carnivals). Special events are occasional events that attract extraordinarily high travel demand within a relative short period and have potential effects on the nearby transport systems around the event venue (Dunn, 2007). Numerous studies on the forecasting of the travel demand associated with special events, in terms of trip attraction, trip distribution, and modal split, have been conducted. Li et al. (2008) and Kuppan et al. (2013) modeled the number of participants attracted to special events in Beijing and Phoenix, Arizona, respectively. Wong and Yu (2011) extended the investigation to origin-destination patterns of trips made by visitors traveling back and forth to a special event held in Macau. Chang and Lu (2013), Pereira et al. (2014), and Shahin et al. (2014) investigated the transport mode choices of participants at different special events. Although much effort has been expended on travel demand research, none of the previous research has considered grave-sweeping or similar types of special events. The underlying factors that influence the columbarium visitors’ travel decisions remain unknown.

Unlike other special events such as concerts or football matches, for which visitors have to arrive at the venues on a fixed date, columbarium visitors have the flexibility to choose their available dates around the festivals for grave-sweeping. Grave-sweeping is a type of family activity for which the travel decisions are made through social interaction between all family members (Manski, 1993; Brock and Durlauf, 2001; Kuwano et al., 2011), especially with consideration of the physical condition of the accompanying elderly members and children. Most of these visitors prefer to meet their other relatives who live apart at nearby interchange locations to buy ritual supplies or dine together before taking feeder services or walking to the columbaria. This makes the visitors’ trip patterns for grave-sweeping different from those for other special events. As a result, the traffic management measures used for other special events cannot be directly applied to this case. Thus, a comprehensive study on travel demand during grave-sweeping is essential.

This paper develops and calibrates models of travel demand for trips to columbaria during the grave-sweeping festivals. Headcount surveys were conducted at 10 selected columbaria to record the number of visitors attracted for grave-sweeping from the weekend before to the weekend after the Ching Ming Festivals of 2013 and 2014. A non-linear regression model was developed to determine the significant factors affecting the trip attraction. A revealed preference survey was carried out at two large-scale columbaria to interview the visitors and collect the travel details of the date they visited the columbarium in the trip diary. The data were used to calibrate a joint logit model to reveal the visitors’ choices on interchange locations and associated feeder transport modes and to determine the related significant factors. This paper also discusses policy insights for future planning of transport facilities and the provision of feeder services to cater to the travel demand for new columbarium developments.

The contributions of this paper are (1) its proposals of a non-linear regression model that depicts the number of visitors attracted to the columbaria and a joint logit model that models the visitors’ travel behavior for trip distribution and modal split to access and leave the columbaria, and (2) its discussion on policy insights for planning the arrangement of transport facilities and the provision of feeder services to cater to this unique travel demand.
The remainder of this paper proceeds as follows. Section 2 introduces the modeling framework of the two-stage approach adopted in this study. Sections 3 and 4 respectively present the data, the formulation, and the results of the trip attraction model, and the joint trip distribution and modal split model. Section 5 discusses the policy implications related to the planning the arrangement of transport facilities and the provision of public transport feeder services. Section 6 concludes the paper.

2. MODELING FRAMEWORK

The conventional travel demand (four-step) modeling approach calibrates trip attraction (or trip generation), trip distribution and modal split sequentially and has been widely adopted in various studies. However, this approach was recently criticized because of the segregation of models in different steps, the use of aggregate models, and the use of different explanatory variables in the modeling steps (Malayath and Verma, 2013). To address these limitations, we attempted to integrate the modeling steps of trip distribution and modal split into a joint logit model, which assumes that the visitors make these decisions simultaneously but not sequentially. The assumption is made based on the notion that the choice of interchange location would be affected by the public transport provided at the interchange location. The modeling framework was inspired by Anas (1981), who extended the traditional multinomial logit model to jointly model the choices of residential locations and transport modes. This doubly-constrained gravity model was later shown to be identical to a multinomial logit model of joint origin-destination choice (Anas, 1983). Thereafter, the joint logit model was popularly applied to other research when combining trip distribution and modal split (e.g., Tamin, 1997; De Grange et al., 2010, 2013). This approach was also adopted by the Hong Kong Government in the Third Comprehensive Transport Study (Transport Department, 2001) for transport planning.

![Figure 1. Modeling framework of the two-stage approach](image-url)

This study therefore adopts a two-stage approach to modeling the travel demand towards columbaria during the grave-sweeping festivals as shown in Figure 1. For trip attraction, the first stage uses a non-linear regression model that predicts the number of visitors entering the columbaria. For trip distribution and modal split, the second stage uses a joint logit model that estimates the visitors’ choices of interchange locations and feeder transport modes when traveling to and from the columbaria.
3. TRIP ATTRACTION

The first step in travel demand modeling is to estimate the trip attraction for columbaria, which predicts the number of visitors accessing a columbarium on certain days (the festival dates and neighboring weekends) surrounding the two traditional grave-sweeping festivals. The trip rate method, which is commonly adopted for this purpose (e.g., Yam et al., 2000; Tan and Fan, 2003; Regidor, 2007), suggests multiplying the number of occupied niches in the columbarium by the average trip rate obtained from other similar developments. However, we believe this method to be suitable only for typical trip estimations such as estimating the number of commuting trips in a normal weekday. For the special event of grave-sweeping, for which the visitors concentrate highly on the festival dates and the neighboring weekends, assuming a fixed trip rate while ignoring the variation in arrivals between the visit dates is undesirable. Therefore, we converted the trip rate model into a non-linear regression model by introducing a date factor (i.e., the number of days deviated from the festival date) to incorporate the variation across different dates around the grave-sweeping festivals. It is worth mentioning that the trip attraction to the columbarium on one day can, in fact, be considered the trip generation from that columbarium. Because the visitors will leave the columbarium after their visits, trip attraction should be the same as trip generation.

3.1 Headcount Survey

To facilitate the model calibration of trip attraction, a headcount survey was conducted at the entrances of 10 selected columbaria in Hong Kong from 9 am to 4 pm from the weekend before to the weekend after the Ching Ming Festivals of 2013 (i.e., March 30, 31 and April 4, 6, 7, 13, 14) and 2014 (i.e., March 29, 30 and April 5, 6, 12, 13) to record the number of visitors entering the columbarium for grave-sweeping at 15-minute intervals. To improve estimation accuracy, the entry headcount excluded the columbarium staff, policemen, and ritual supplies salesmen.

Figure 2 illustrates the number of occupied niches and average headcount of the 10 columbaria surveyed. The figure shows that the surveyed columbaria are widely spread over the territory. In particular, four are identified as large-scale columbaria with more than 40,000 occupied niches, and two are small-scale columbaria with only a few hundred occupied niches. Most of the columbaria generate average trip rates (i.e., the number of visitors per occupied niche) within a range of 0.13 and 0.46, except that for Filial Park, which reaches up to 1.40. There are two possible reasons for this. 1) Filial Park is a small-scale columbarium. For convenience, people tend to entomb their ancestors (maybe two or more) in niches at the same large-scale columbarium to avoid making a subsequent trip to another columbarium to commemorate other ancestors. This leads to lower trip rates for the large-scale columbaria. 2) Filial Park was newly established in 2013. The other nine columbaria were mainly established from the 1950s to 1970s (we may assume that most of the niches were occupied a few years afterwards). Because the niches have been occupied for a long time in these nine columbaria, from our observations, some appeared to have no visitors for grave-sweeping. It is possible that there were no more living descendants in that family, or the descendants had moved away from Hong Kong and could not visit during the festivals.
3.2 Regression Model Formulation

The number of visitors attracted to each columbarium was modeled by non-linear regression and considered to be affected by the following factors:

**Number of occupied niches**: The number of occupied niches is a major component of the estimation model using trip rates. A columbarium with more occupied niches generally attracts more visitors during the grave-sweeping festivals.

**Number of days deviated from the festival date**: As explained in Section 3.1, instead of using a fixed trip rate to predict the number of visitors, a date factor (i.e., the number of days deviated from the festival date) was adopted to estimate the trip rate to incorporate the variation across different dates surrounding the grave-sweeping festivals. The number of visitors is expected to peak during the festival dates and drop subject to the day difference. Of the numerous model forms tested, the exponential form, with its reasonable results, was found to be a better fit for the headcounts collected.

Although the aforementioned number of ancestors entombed in the same columbarium and the number of years the niches are occupied in a columbarium could be factors that influence the number of visitors attracted, these numbers could not be obtained directly from our headcount surveys and were thus not incorporated into our prediction model. They are left behind for future studies.

The non-linear regression model calibrated for trip attraction therefore takes the following exponential form:
\[ H_{cd} = N_c \left[ R \exp\left( \theta^D D_d \right) \right], \tag{1} \]

where \( H_{cd} \) represents the headcount from our survey and is equal to the number of visitors entering columbarium \( c \) on date \( d \), \( N_c \) represents the number of occupied niches at columbarium \( c \), and \( R \exp\left( \theta^D D_d \right) \) represents the estimated trip rate. In the latter term, \( D_d \) is the number of days deviated from the festival date (e.g., it equals 7 for the date of April 12, 2014, given that April 5 was the date of the Ching Ming Festival). \( R \) and \( \theta^D \) are the calibrated coefficients of the model. For a columbarium with no niches (i.e., \( N_c = 0 \)), the number of visitors to that columbarium will be equal to zero. On the other hand, for the specific date of the Ching Ming Festival (i.e., \( D_d = 0 \)), the trip rate to a columbarium for grave-sweeping will be equal to \( R \).

### 3.3 Regression Model Results

The coefficients in the non-linear regression model are tabulated in Table 1. Both are significant at the 1% level with reasonable signs, implying that the number of days deviated from the festival date is a significant factor influencing the trip rate to a columbarium. The number of visitors accessing the columbarium can be found by multiplying the estimated trip rate by the number of occupied niches. This approach improves on the traditional trip rate method by effectively estimating the number of visitors on a particular date during the festival period.

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Model parameters</th>
<th>Coefficients(^a)</th>
<th>( t )-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of days deviated from the festival date</td>
<td>( R )</td>
<td>0.59</td>
<td>6.3</td>
</tr>
<tr>
<td>from the festival date</td>
<td>( \theta^D )</td>
<td>-0.17</td>
<td>-2.9</td>
</tr>
</tbody>
</table>

\(^a\) All parameters are significant at the 1% level.

Based on the model results above, the trip rate reaches a peak value of 0.59 on the festival date. It is logical that this value is higher than the range initially discussed in Section 3.1. According to the exponential form, the trip rate starts dropping and becomes less than 0.01 after the number of days deviated exceeds 28 (equivalent to 4 weeks). From the application perspective, if the handling capacity of the transport facilities and services provided can be predefined, this model can help identify on which dates the columbarium will attract too many visitors and severely affect local traffic. The results can also define the minimum required handling capacity to cater to the visitors’ travel needs and indicate the need for temporary traffic management schemes on several peak dates.

It is important to clarify that we conducted the headcount survey only on the festival dates and the neighboring weekends, so the non-linear regression model can only be applied to predicting the number of visitors for these dates; it is not applicable for weekdays. Trips made on weekdays during the festival period comprised only 3% of the peak value. We anticipated that this value would further decrease for other weekdays. As a result, we considered the effects on traffic on the weekdays to be minimal, and they were neglected in our study.
4. TRIP DISTRIBUTION AND MODAL SPLIT

The following steps of travel demand modeling estimate the trip distribution to interchange locations and the corresponding modal split of choosing different feeder services (e.g., minibus or shuttle bus) to that location. We developed a model to integrate these steps because the visitors choose an interchange location close to the columbarium and consider the operational characteristics of the available feeder services at that location (e.g., short service headway and low fare). The visitors’ choices of interchange location are dependent on the mode choice decisions. Therefore, it is reasonable to assume that the columbarium visitors make these two travel decisions simultaneously as modeled in the joint logit model.

4.1 Questionnaire Survey

A revealed preference questionnaire survey was conducted at two popular large-scale columbaria in Hong Kong, namely Po Fook Memorial Hall and Yuen Yuen Institute, from the weekend before to the weekend after the Ching Ming Festival of 2013 (i.e., March 30, 31 and April 4, 6, 7, 13, 14) from 9 am to 4 pm on each date to collect trip data from the visitors for modeling of their choices of interchange location and feeder services to access and leave the columbarium. In total, 487 responses were collected for model calibration, and the overall response rate was about 25%. Po Fook Memorial Hall is about a 5-minute walk from a railway station, but Yuen Yuen Institute is far away from a railway station, and the journey takes about 15 minutes by a feeder service from the nearest railway station.

Our questionnaire consisted of two parts: 1) demographical background and visit characteristics of the respondents and their families, and 2) detailed information about their trips to access and (their plan to) leave the columbarium.

Because grave-sweeping is a type of family activity, most of the visitors would arrive at the columbaria with their family members. Therefore, it might not be suitable to use the individual personal particulars of the interviewees to explain their family travel decisions. Therefore, all of the demographical background data were designed to be collected on a family basis (e.g., family car ownership and family monthly income) in the first part of the questionnaire. We also asked the respondents to report their (average) visit frequency in a year and the number of ancestors being commemorated to further explain the travel pattern. The visitors’ preference for entombing their ancestors in niches versus graves was also collected to predict the need for such development in the future.

Figure 3 presents the demographical distribution and visit characteristics of the 487 respondents. It shows that nearly all respondents (98%) visited the columbaria with their family members. This finding confirms our expectation that grave-sweeping is a family activity. Furthermore, almost 30% of the respondents were accompanied by elderly (aged 65 or above) family members, more than 70% did not own a private car, and about half had a family income less than HK$30,000 a month.

Of the 487 responses collected, 236 were from Po Fook Memorial Hall and 251 were from Yuen Yuen Institute. The numbers of questionnaires collected were not evenly distributed across the seven survey days. In particular, as shown in Figure 3, the number of questionnaires collected on April 13 was particularly low. Moreover, because we believed that the mode and location choice behavior of the visitors would vary across survey dates and locations, weights were assigned to different data collected on the various days in the two surveyed columbaria to avoid sampling bias when calibrating the model in the later stage. For the visit characteristics of the respondents, Figure 3 shows that up to 97% of the interviewed visitors’ families paid visits to the columbaria regularly at least once a year, and about two-
thirds came to commemorate more than two ancestors during the survey. Figure 3 provides a good example for controlling travel demand to columbaria during the grave-sweeping festivals. If all of the ancestors in a family are entombed in the same columbarium, their descendants can avoid making a subsequent trip to another columbarium to commemorate other ancestors. This could be a policy direction the government could take to lower travel demand to columbaria to alleviate the effects on local traffic.

Figure 3. Demographical distribution of interviewed visitors’ families and their visit characteristics

Figure 4 shows the detailed distribution of the dates of respondents’ visits. Of the respondents, 50% claimed that they would visit the columbaria again during Chung Yeung Festival, and only 14% would also come on other dates of visits (e.g., ancestors’ afterlife birthday or date of death). These results clearly indicate that visits to the columbaria concentrate around the two traditional grave-sweeping festivals, and the most severe transport problems are more likely to occur during Ching Ming Festival. The number of visitors reduces to half during Chung Yeung Festival, thus causing less serious effects on local traffic. Only a small proportion of the respondents reported that they would visit the columbaria during non-festival periods in a year; thus, the influence on local traffic is likely to be minimal.

The results also show that more than 70% of the respondents preferred to entomb their ancestors in niches after cremation, whereas only 6% preferred burial. The respondents explained that this was mainly the will of their ancestors and that a columbarium normally has better accessibility than a cemetery (cemeteries in Hong Kong are normally located on hillsides). This outcome reflects the significant demand for niche spaces in columbaria in the future given the estimated number of deaths in Hong Kong in the coming decades (Food and Health Bureau, 2010).
In the second part of the questionnaire, we asked the interviewees to report the travel details of the date they visited the columbarium in the trip diary, including 1) the trip origin heading to the columbarium (i.e., the interchange location to take the feeder service or whether they arrived there with a specific purpose, such as to gather other family members or buy ritual supplies), 2) the selected feeder service (including walking) to the columbarium with the corresponding total waiting and walking times, in-vehicle travel time, and fare (both equal to zero for a walking trip), and 3) the details of the planned trip for leaving the columbarium.

To hedge against sampling bias, a weight was assigned to the data from each questionnaire collected on a particular day and at a particular surveyed columbarium. The weight was defined as the headcount proportion over the questionnaire proportion of the surveyed date and location, calculated as:

$$W_{cd} = \frac{H_{cd}}{\sum_{m \in M} \sum_{n \in N} H_{mn}} / \frac{Q_{cd}}{\sum_{m \in M} \sum_{n \in N} Q_{mn}},$$

where $W_{cd}$ and $Q_{cd}$ represent the weight assigned to and the number of responses collected at columbarium $c$ on date $d$, respectively. Based on this calculation, the responses collected on April 13 (identified as the date on which the data collected were underrepresented in the sample) were magnified by more than two times to address the sampling bias problem.

### 4.2 Logit Model Formulation

The visitors’ choices of interchange locations and the corresponding feeder services were modeled by a joint logit model and were considered to be affected by the following factors:

**Number of zones apart:** We expected that when choosing an interchange location, the visitors would prefer to select a zone close to the columbarium. Instead of using a distance attribute measured in meters between the interchange location and the columbarium, we adopted the number of zones apart from the columbarium as an alternative measure. We divided the areas of influence into zones as specified in the zoning system of the Base District Traffic Model (BDTM) and aggregated the interchange locations and the columbaria into their respective zones to calculate the number of zones apart. The BDTM zoning system with
2567 zones was defined based on the Planning Vision and Strategy 405 Zone boundaries used in the Third Comprehensive Transport Study and the Street Block Components of the Tertiary Planning Units (Transport Department, 2010). This zoning system can therefore distinguish locations in different street blocks in which the characteristics of each zone become homogeneous. The system was widely used in Hong Kong for transport planning (e.g., Lau et al., 2005).

**Availability of direct feeder services:** To decide on an interchange location to access the columbarium, the visitors would prefer to select a zone where at least one direct feeder service is available to minimize walking time. This is particularly true if the columbarium is far away from the interchange location. Hence, feeder service availability is expected to be a significant factor influencing the visitors’ choices of interchange location. It is thus important to capture this factor to plan the arrangement of these interchange locations to avoid overcrowding.

**Total waiting and walking times:** The total waiting and walking times were directly extracted from the trip diary of the respondents. As shown in Figure 3, about 30% of visitors were accompanied by their elderly family members. Because of the lower mobility of the elderly, this group of visitors was likely to make travel decisions based on shorter total waiting and walking times.

**In-vehicle travel time:** The in-vehicle travel time was also obtained from the trip diary. If the visitors walked from the interchange locations to the columbarium, the value equals zero.

**Out-of-pocket cost:** The visitors were expected to select a feeder service with a lower fare. If they did not take any kind of feeder services to access the columbarium, the value equals zero. If they arrived at the columbarium by their private cars, for which the cost was not explicitly known, the out-of-pocket cost was estimated by the sum of fuel cost calculated with respect to the distance traveled, the parking cost of a nearby car park with respect to the time stayed in the columbarium, and the tunnel toll charged, if any.

To depict the decisions of the visitors on the interchange locations for feeder services and the corresponding transport mode choices, we developed a joint logit model for the trip distribution and modal split based on the above attributes. The model takes the following form (McFadden, 1974):

$$P_{ijf}(q) = \frac{\exp U_{ijf}(q)}{\sum_{m} \sum_{n} \exp U_{mijn}(q)},$$

(3)

where $P_{ijf}(q)$ is the probability that an individual visitor $q$ selects an interchange location at zone $i$ and feeder service $f$ to access or leave his/her designated columbarium in zone $j$ for grave-sweeping. If the visitor chooses the interchange zone that is the same as the columbarium zone, then $i = j$. $U_{ijf}(q)$ is the deterministic utility used to capture the factors influencing the decision of visitor $q$. The higher utility of a choice implies a higher probability of that choice being selected.

The utility in Equation (3) consists of two parts, the trip distribution (attributes in the first blanket) and the modal split (attributes in the second blanket):

$$U_{ijf}(q) = (\alpha^Z Z_{ij} + \alpha^A A_{ij}) + (\beta^W W_{ijf} + \beta^I I_{ijf} + \beta^F F_{ijf}),$$

(4)
where \( Z_{ij} \) represents the number of zones apart from an interchange location at zone \( i \) to the visitor's designated columbarium at zone \( j \) (e.g., it equals one if zone \( i \) is an adjacent zone of zone \( j \)), and \( A_{ij} \) represents the availability of direct feeder services to transport the visitors from zone \( i \) to zone \( j \). \( \alpha^Z \) and \( \alpha^A \) are the associated coefficients for modeling the trip distribution. \( W_{ijf} \), \( I_{ijf} \), and \( F_{ijf} \) represent the required total walking and waiting times, in-vehicle travel time, and out-of-pocket cost, respectively. If the visitor takes the feeder service \( f \) from zone \( i \) to \( j \). \( \beta^W \), \( \beta^I \), and \( \beta^F \) are the associated coefficients for modeling the modal split.

It is important to clarify that all of the attributes in Equation (4) indeed take into account the perceived values to a visitor of the associated decisions of interchange location and feeder service. We assume here that the visitors evaluate the options based on their experience of visiting the columbaria in past years and that every visitor has the same perception of the utility function attributes. Therefore, the subscript \( q \) can be omitted in each attribute on the right-hand side of Equation (4) for simplicity.

**4.3 Logit Model Results**

An econometric modeling software NLOGIT was adopted, which uses the maximum likelihood estimation method to determine the coefficient of each variable in the joint logit model for interchange location and feeder service choices. The coefficient of each variable is tabulated in Table 2. All of the coefficients are significant at the 5% level, and their signs meet our expectation, which implies that the number of zones apart, the availability of direct feeder services, the total waiting and walking times, the in-vehicle travel time, and the out-of-pocket cost significantly influenced the visitors’ choices of interchange location and feeder service during the grave-sweeping festivals.

<table>
<thead>
<tr>
<th>Choices</th>
<th>Explanatory Variables</th>
<th>Coefficients</th>
<th>( t )-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interchange location</td>
<td>Number of zones apart</td>
<td>-0.02(^b)</td>
<td>-2.3</td>
</tr>
<tr>
<td></td>
<td>Availability of direct feeder services</td>
<td>0.47(^a)</td>
<td>3.8</td>
</tr>
<tr>
<td>Feeder service</td>
<td>Total waiting and walking times (min)</td>
<td>-0.03(^a)</td>
<td>-6.2</td>
</tr>
<tr>
<td></td>
<td>In-vehicle travel time (min)</td>
<td>-0.05(^a)</td>
<td>-8.0</td>
</tr>
<tr>
<td></td>
<td>Out-of-pocket cost (HK$)</td>
<td>-0.01(^a)</td>
<td>-3.6</td>
</tr>
</tbody>
</table>

\(^a\) Parameters are significant at the 1% level; \(^b\) Parameters are significant at the 5% level.

For the choice of interchange location, the negative coefficient of -0.02 for number of zones apart from the designated columbarium implies that the visitors preferred choosing an interchange location with a shorter distance to the columbarium. However, the coefficient for availability of direct feeder services is uniquely positive at 0.47. This shows that the visitors had a stronger intention to choose a zone where a direct feeder service is available to access the columbarium without further walking.

The coefficients related to the choice of feeder service (total waiting and walking times, in-vehicle travel time, and out-of-pocket cost) are all negative, ranging from -0.01 to -0.05. This is logical and tells us that the visitors preferred going to a columbarium with shorter walking and waiting times, a shorter in-vehicle travel time, and a lower out-of-pocket cost. Interestingly, unlike the similar mode choice studies undertaken for other trip purposes (e.g., Habib, 2013; Forsey et al., 2014; Ho and Mulley, 2015), the coefficient for the in-vehicle travel time is significant.
travel time possesses a larger negative value than that for the waiting and walking times. This implies that the visitors did not have a strong resistance to walking (possibly due to the festival tradition of hiking in Ching Ming and Chung Yeung Festivals), and they would not prefer taking the feeder services if the associated in-vehicle travel time was not shorter than the walking and waiting times.

5. POLICY INSIGHTS

This paper provides a non-linear regression model for predicting the number of visitors attracted to (or generated from) a columbarium subject to the number of occupied niches, and develops and calibrates a joint logit model for understanding the factors that influence the visitors’ choices of interchange location and the associated feeder transport mode. These two models provide insights into planning the arrangement of transport facilities and the provision of feeder services for new columbarium developments.

From the regression model, we found that the number of days deviated from the festival date is a significant factor that influences the number of visitors on that date. This helps us identify the dates that would attract too many visitors, thus exceeding the handling capacity of the existing nearby transport facilities. Solutions would be to consider implementing temporary traffic management measures (e.g., suspending access of private cars and initiating a pedestrianization scheme) on these dates or enhancing the overall handling capacity (e.g., by widening the walkway bottleneck and expanding the public transport interchange).

From the logit model, we determined that visitors choose an interchange location in a zone that is close to the columbarium and has at least one direct feeder service to access the columbarium. This information will be helpful in planning the arrangement of interchange facilities surrounding the columbarium (e.g., setting up additional interchange locations to spread high travel demand over several locations) and determining the demand for feeder services. New locations that can provide direct public transport service to access the columbarium could effectively divert visitors from the original congested interchange location to the new one, and that also helps to reduce the travel demand on the public transport service in the original congested interchange location. As the demand drops, the waiting time for services could be reduced and thus avoid causing dissatisfaction to the visitors. In addition, travel demand could be distributed across different interchange locations by controlling the fares charged by public transport services from different interchange locations.

6. CONCLUSION

This study modeled the travel demand patterns of columbarium trips during the traditional grave-sweeping festivals to estimate the trip attraction and predict the trip distribution and modal split. The on-site data collection was conducted during the Ching Ming Festivals of 2013 and 2014 consisted of a headcount survey and a revealed preference questionnaire survey. The headcount survey recorded the number of visitors entering 10 selected columbaria during the festival periods, and the data were used to calibrate a non-linear regression model for trip attraction. The results showed that the number of niches and the number of days deviated from the festival date significantly affect the number of visitors entering the columbaria. The model provides the arrival profile across different dates and addresses the limitation of the traditional trip rate method. The revealed preference questionnaire survey interviewed 487 columbarium visitors at two selected large-scale columbaria for their trip
diary on that visit date, and the data were used to calibrate a joint logit model for trip distribution and modal split. A weight was assigned to the data from each questionnaire collected on a particular day and at a particular surveyed columbarium to hedge against sampling bias. The model results indicated that the number of zones apart, the availability of direct feeder services, the total waiting and walking times, the in-vehicle travel time, and the out-of-pocket cost are the significant factors influencing the visitors’ travel choices of interchange locations and the associated feeder transport modes. The model results provide several policy insights for planning the arrangement of transport facilities and the provision of feeder services to divert high travel demands on the peak dates and reduce the effects on local traffic.

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REFERENCES


