European Transport \ Trasporti Europei (2021) Issue 84, Paper n° 1, ISSN 1825-3997

https://doi.org/10.48295/ET.2021.84.1

Sub-activity site selection and activity choice modelling in planned special events

Mahmut Esad Ergin [1*], Hüseyin Onur Tezcan [1]

[1] *Istanbul Technical University, Department of Transportation Engineering*

Abstract

The purpose of the study is to evaluate the impacts of the variables on site selection decision of the spectators just before the main activity in order to engage in eating, having fun and performing other types of activities. A multinomial logit modelling framework is hired to model activity patterns within PSE circumstances. Activities were classified into three groups that are "Eating", "Entertainment", and "Other". Model estimation on PSE survey data set from selected stadiums in Istanbul shows that due to the congestion, as travel time and activity duration increase the spectators inclined to be around the stadium 184 minutes in average before the starting time of the main activity. The results obtained from this study can be used as a micro input for the macro studies such as transportation master plans and urban plans and can offer complementary research areas for PSE traffic management and urban planning.

Keywords: Planned special event, Activity choice, Multinomial logit model, Survey analysis.

1. Introduction

A planned special event (PSE) is a public activity with a predetermined date, venue, and duration that may affect the regular service of the surface transport network due to enhanced traffic demand and/or decreased capability related to event planning (Dunn, 2007). PSE impacts the transportation network with its known location and scheduled time as a result of increases in travel demand or decreases in the capacity of road segments (Latoski et al., 2003). PSEs frequently attract people from anywhere with different cultures or different background into the host society, and then there can be an interaction between societies and cultures (Cook et al., 2010). Moreover, people create this interaction voluntarily to share their cultures and the driven force of this sharing can be said to be PSE (Getz, 1997). Events can be classified in different ways in terms of their size, form, content, location and impact area (Getz, 1997). The impact area of the main activity (PSE) can be specified physically by the site selection of the chosen sub-activity by the participators.

Even though PSEs are planned occurrences, they raise the travel demand, abnormally and temporarily (Skolnik, et al, 2008). Consequently, event-based travel demand modelling that is used to model PSE demand emphasizes the temporal distribution of

* Corresponding author: Mahmut Esad Ergin (esadergin@gmail.com)

travel demands on the network for a short period of day while the traditional travel demand models such as 4-step and activity-based models represent daily routine travel demand (Yaun et al., 2009; Kuppam et al., 2010). For PSE, Day (2008) expressed that trip makers decide their departure times under consideration of the possible travel times and arrival times for their activity. In the literature, generally the term “activity” is used for the main activity. This can be said for the main activity, but arrival times for the sub-activities in the PSEs should be examined, as well.

In the literature, PSE models generally consider only the main activity and travel demand from other zones to the event venues is solely forecasted (Kuppam et al., 2010; Li et al, 2017; Shakibaei et al, 2014; Frawley and Hoven, 2015). Moreover, PSE is analyzed by traffic management in some studies (Dunn, 2007; Frantzeskakis and Frantzeskakis, 2006; Latoski et al, 2003; Zagidullin, 2017; Yaun et al., 2009) and spectator (customer) satisfaction point of view in others (Shin and Lyu, 2019). Generally, the literature on PSE studies is dominated by large-scale events such as Olympic Games, World Cup Tournaments, Winter Games, etc. (Frantzeskakis and Frantzeskakis, 2006; Yaun et al., 2009; Frawley and Hoven, 2015).

An example is the study by Clark et al. (2016) who argue the impacts of mega-scale PSE’s on the environment in terms of city planning and indicate urban regeneration challenges from the local residents' point of view. In this study, the PSE was a mega-scale event, which is called Glasgow 2014 Commonwealth Games. In another study, Giampiccoli et al. (2015) compared the FIFA World Cup Football championship which is organized every four years and Comrades Marathon that is held yearly. They presented the effects of these sports events on economic development, tourism, and city plans. An analysis of these studies shows that mega-scale events have an important influence in the local economy. In another study, Kuppam et al. (2013) presented distinguishing features of PSEs which helped in data collection which are event frequency, predicted attendance, venue type, event start and end time, single versus multiple days, day of week, event market area, local versus regional attendance.

There are many studies on trip chaining and activity based modeling in the literature. Daisy et al. (2018) tried to introduce the relationship between socio-demographics, trip attributes, and land use pattern with tour complexity and mode choices by using a Multinomial Logit (MNL) model for tour mode selection and ordered probit model for tour complexity. In this study, there is no distinction or hierarchy, such as a main activity and a derived activity (sub-activity), as in PSE models. Ettema et al. (2007) develops a model of activity and trip scheduling in terms of activity duration, time of day preference and schedule delays effects by using discrete choice modelling approach. As a result of the model, the most important variables influencing the scheduling of the work tour are time-of-day preferences and schedule delays and they are strongly linked with the work activity. Moreover, for estimating urban passenger travel demand, Bowman and Ben-Akiva (2000) proposed an integrated activity-based discrete choice model system of an individual's activity and travel demand. They classified the activities as primary and secondary, and tried to predict the mode choice by using a tour model. In addition, the places where activities are carried out are also indicated as zones. In the study, a basic type of tour is defined as “home-work-other-work-home”, and the "other" is defined as secondary activity. In our study, primary event can be matched as PSE and secondary activities as "sub-activities". Unlike the studies in the literature, the main focus of our study is the sub-activities.

While PSE modelling is rarely studied, sub-activity demand modelling is almost not studied at all. In reality, sub-activities are as important as the main activity for traffic management of the PSE. The zones that PSEs take place play the role of hot spots or meeting areas of the participators and this is especially true in special events such as games. For most of the sports games around the world, there is a meeting point for the spectators to experience the atmosphere before the game and the fans go to the stadium with slogans from that point. Especially in cities that have more than one sport teams, spectators come together at their known location before the game starts. Accordingly, the zones that host those meeting points will collect and attract the travel demand firstly. Furthermore, sub-activities should also be considered for the site selection to identify the impact area of the main events.

This paper aims to address the issue of PSEs on the metropolitan scale according to site selection criteria of the sub-activities and proximity of the chosen activities just before the main activity. We emphasize on the previous steps of the main activity participation which is a gap in the literature for individuals. In literature, the main activity is emphasized generally, but the previous steps or activities are neglected or considered separately. However, activities that are participated in just before the main activity which are called sub-activities in this study are related with the main activity. Moreover, due to the increased travel demand, intense activity participation, and cultural sharing, the behavior of the spectators coming together should be examined, as well. In this context, departure time is one of the crucial topics for transport demand management. For example, Elmorssy and Tezcan (2019) stated that destination, travel mode and departure time is very essential for modelling and obtaining the relationship between congestion and trip distribution over time in a day. However, PSE is related with weekend and weekday trip demand and sometimes it affects peak time traffic in the city. On the other hand, spectators who already paid for the tickets, mostly consider the arrival time more than departure time. So, besides departure time, arrival time should be taken under consideration while modelling. Spectators, especially in a congested city such as Istanbul, arrive at the place before the main event start. The selected place depends on the type of activity to participate, the traffic situation of the roads leading to the main activity area and its surroundings, travel duration between the place to the venue, and the characteristics of the participants. Also, the proximity of the locations that are chosen by participants for the sub-activities varies. This study will not be similar to the four-year global or national PSEs used in most of the previous studies but will lead to studies on the social, cultural and economic impact of ordinary sport games that are played every week. The paper concerns the previous step of participating in a PSE and the variables that affect the site selection of the chosen activity are modelled by using the multinomial logit modelling (MNL) approach.

The paper is designed as follows. The next section presents an overview of the selected stadiums, survey methodology, and data. The third section demonstrates the modelling methodology, and the fourth section confronts details of the model application and estimation results. The final section presents the discussions and final thoughts.

2. Selected Stadiums, Survey Methodology and The Data

In this study, 3 stadiums that belong to the 3 biggest football clubs, Besiktas, Fenerbahce and Galatasaray, with the most fans in Turkey and Istanbul are selected. Among these stadiums, Besiktas Vodafone Park with a capacity of 41,903 and Fenerbahce Ulker Stadium with a capacity of 50,530 are located in two of the central districts, Besiktas and Kadikoy, respectively. On the other hand, Galatasaray Turk Telekom Stadium with a capacity of 52,280 is located at a peripheral region in the Sariyer district. Vodafone Park and Fenerbahce Ulker Stadium are connected with roadways, tram lines, metro lines, and sea lines to the transportation network of the city. However, Turk Telekom Stadium is connected with roadways and a metro line to the transportation network of the city. This metro line almost only serves for the spectators on match days.

The data used in this study were collected by face-to-face conducted surveys. For each team, 7 game days were selected in 2018 – 2019 Turkish Super League. At each game day the surveys started about 3 hours before the games and completed before the game started. The surveys were conducted only with home team fans waiting in the area that is closed to traffic and fully secured by police and they were selected randomly. On the other hand, the questioners split into groups by the entrances of the stadiums in order to collect non-biased statistics and fan details from various stadium stands. Moreover, interviewing with any of the spectators was conducted closely and in the absence of others' attention to avoid bias.

The survey consists of two parts. In the first part, socio-economic information of the fans was asked and their fandom levels were inquired with a few structural questions. As Bhat and Koppelman (2003) pointed out, the activity-based approach requires time-used survey data for analysis and forecasting. For this reason, in the second part of the questionnaire, time use questions were asked and it was aimed to collect data such as activity type, activity cost and activity duration related to all activities (out of home) carried out by individuals during the same day with the PSE. Moreover, trip characteristics of the individuals were asked related to the participated activities. The questionnaire consists of 17 questions and sub-questions that were asked to randomly selected fans waiting outside the stadium.

The general descriptive statistics of the data (Table 1) shows that the number of valid surveys in the studied areas of Besiktas Vodafone Park, Fenerbahce Ulker and Galatasaray Turk Telekom Stadium where pedestrian safety is provided between the police control line and the entrance gates of the stadium is 1,168. According to the current 1168 surveys, the average age of the fans is 30 and only 6% are women. At most the 25 - 34 age group fans follow the game in the venue (38%). Generally, fans not only come from districts of Istanbul, but also from out of Istanbul and even abroad. According to data 24% (n=277) of the respondents were from out of the city and 3% (n = 39) from abroad. 26% of the participants stated that they were included in the monthly income group of TRY 3,501-5,000 (TRY per 1 EUR varies between 5.98 and 6.90 in 2018). The average monthly income is around TRY 3,211. People attended to soccer games mostly with a friend (n = 704; 60%). On the other hand, 35% and above of Fenerbahce and Galatasaray fans follow all home games in one season.

Based on the data collected, the sub-activities that were performed before the game (main activity) were classified as; “Eating”, “Entertainment” and “Other (shopping, visiting, sightseeing, job interview, etc.)”. According to data, the number of spectators who participate “Eating”, “Entertainment” and “Other” activities are 397 (34%), 463 (40%), and 143 (12%), respectively but separately. These percentages are calculated independently because some of the spectators may participate more than one activity. Therefore, each activity participations are analyzed and modeled independently from each other. On the other hand, 275 individuals (24%) did not perform any sub-activity and directly travel to the stadium from their homes or workplaces. As it is expected, for three classified activities, the total average duration of the activities performed during the weekend days are higher than the weekdays. The average duration of the Eating activities carried out on the weekend days is 6% more than the average duration of the weekly Eating activities. The value of the difference is 19% for Entertainment activities and 17% for other activities (Table 2). The group that spends the most time in the Entertainment and Other activity groups is the 15–24 age group of spectators. Although the 25–44 age group did not spend their time as much as other age groups, they spent more money than the rest of the groups for all three types of activities. While male spectators allocate more time for the Eating and Entertainment activities than the female spectators, females spend more time on the Other activity group, and the activity cost of the groups changes accordingly. The spectators who come from out-of-Istanbul spend more time on Entertainment and Other activity groups. The spectators from abroad pay almost twice of other spectators' spending on Other. The spectators who participate in the matches from Istanbul spend the least time and money in all three activity groups. Even though, the spectators who have seasonal ticket spend more money on Eating and Other, they spend the least time on the eating and entertainment activities. Similar to this, as the amount of frequency of the attending of the games increases, the tendency to spend more money on the Eating increases. It is not surprising that the spectators with a monthly income level below TRY 1,800 spend the least money on the activities except the Entertainment. As the monthly income level of the spectators' increases, the activity cost of the Eating and Other activities increases. Just like the income level, owning a private vehicle also increases the amount of money spent on activities. The spectators who participate in games alone spend much more time on the Eating activity than the others and also, they are the spectator group that pays a lot more for the Other activities. On the other hand, the spectators who come to the games with their family members expend more than other spectators for the Entertainment. Spectators who follow their team's away matches by paying monthly payments for the TV channel make the highest amount of payments in all the three activity groups. However, the spectators who spent the most time in entertainment and other activities follow the away games of their teams in the cafe.

Table 1: Descriptive Statistics (N=1,168)

Criteria	*Classification*	*N*	*Percentage*	*Criteria*	*Classification*	*N*	*Percentage*
Age Groups	15-24	361	31%	Private Car Ownership	No	648	55%
	25-34	446	38%		Yes	520	45%
	35-44	265	23%	Who Does the Activity with?	Alone	259	22%
	45-54	79	7%		Friends	704	60%
	55 +	17	1%		Older Family Member	71	6%
Gender	Woman	68	6%		Adult Family Member	100	9%
	Man	1100	94%		Young Family Member	34	3%
Residential Status	Out-of-town	277	24%	Ticket Types	Gift Match Ticket	113	10%
	Abroad	39	3%		Gift Seasonal Ticket	18	2%
	Istanbul	852	73%		Match Ticket	620	53%
Income Groups	< 1,800	289	25%		Seasonal Ticket	417	36%
	1,800 – 3,500	249	21%	Seasonal Ticket	No	733	63%
	3,501 – 5,000	307	26%		Yes	435	37%
	5,001 – 6,500	140	12%	How Often Do You Participate in Matches?	0 - 4	382	33%
	6,501 – 8,000	58	5%		5 - 8	248	21%
	8,000 +	125	11%		9 - 13	139	12%
Top-5 Job/Task	Student	285	24%		14 +	399	34%
	Tradesman	117	10%	How Do You Watch the Matches outside the Stadium?	Do Not Watch	79	7%
	Engineer	58	5%		Paid Channel	664	57%
	Civil Servant	42	4%		Cafe	223	19%
	Teacher	39	3%		Internet	202	17%

Table 2: Sub-Activity Duration and Costs with Respect to Various User Groups

		Eating (n=397, 31%)			*Entertainment (n=463, 40%)*			*Other (n=143, 12%)*		
		Avg. Duration (minutes)	*Avg. Cost (TRY)*	*Avg. # of Activities*	*Avg. Duration (minutes)*	*Avg. Cost (TRY)*	*Avg. # of Activities*	*Avg. Duration (minutes)*	*Avg. Cost (TRY)*	*Avg. # of Activities*
Day of the Match	Weekend	262	100	1.66	166	62	1.40	178	68	2.08
	Weekdays	248	73	1.62	139	60	1.54	152	68	2.22
Age Groups	15-24	134	31	1.66	168	44	1.43	176	35	2.06
	25-44	120	51	1.64	141	70	1.50	155	91	2.21
	45+	147	47	1.63	160	55	1.54	147	58	2.33
Gender	Female	111	41	2.00	144	56	1.48	199	71	2.30
	Male	127	45	1.63	151	61	1.48	158	68	2.16
Residential Status	Abroad	141	54	1.85	172	88	1.78	233	148	2.20
	Out-of-Istanbul	145	51	1.89	199	93	1.72	163	68	2.30
	Istanbul	119	44	1.53	135	51	1.40	150	57	2.05
Income Groups	< 1,800	139	27	1.64	163	50	1.42	144	34	2.03
	1,800 – 3,500	121	43	1.73	159	43	1.52	184	35	2.30
	3,501 – 5,000	128	47	1.55	132	62	1.43	170	51	2.16
	5,001 – 6,500	119	52	1.68	161	85	1.50	165	55	2.29
	6,501 – 8,000	114	58	1.48	121	74	1.61	173	70	2.25
	8,000 +	121	62	1.75	151	79	1.60	141	190	2.12
Private Car Ownership	No	124	39	1.64	151	52	1.48	155	51	2.10
	Yes	129	51	1.65	149	71	1.48	169	90	2.25
Who Does the Activity with?	Alone	132	44	1.52	135	49	1.49	158	109	2.12
	Friends	125	46	1.68	152	59	1.42	165	54	2.25
	With Family Member	123	42	1.68	162	86	1.73	156	61	2.00
Seasonal Ticket	No	133	43	1.70	155	63	1.54	160	60	2.13
	Yes	114	48	1.54	144	57	1.39	165	90	2.26
How Often Do You Participate in Matches?	0 - 4	133	41	1.77	156	71	1.55	177	68	2.25
	5 - 8	135	50	1.66	161	58	1.58	121	39	2.03
	9 - 13	125	43	1.55	123	49	1.53	158	96	1.94
	14 +	113	46	1.54	147	58	1.35	175	85	2.26
How Do You Watch the Matches outside the Stadium?	Do Not Watch	102	49	1.71	144	56	1.36	132	68	2.44
	Paid Channel	131	49	1.61	141	64	1.52	160	82	2.15
	Cafe	125	37	1.68	184	63	1.41	171	40	2.23
	Internet	126	38	1.69	151	49	1.44	164	56	2.04

4. Selected Stadiums, Survey Methodology and The Data

To understand the location choice of the chosen activity, a MNL is estimated in this study due to the mathematical simplicity of the modelling approach.

As it is accepted that in the framework of the utility theory, an individual always selects the alternative that maximizes his/her utility from a set of alternatives. Koppelman and Bhat (2006) used the utility theory general rule as:

$$U_{it} = V_{it} + \varepsilon_{it} \quad \textbf{(1)}$$

where U_{it} is the exact utility of the alternative i for t individual, V_{it} is the deterministic component of the equation that can be observed and estimated by the modeler, and ε_{it} is the stochastic component of the equation that is unknown and cannot be observed.

Error term is not known by the analyst or modeler separately, but, total error terms from the variety of the sources can be represented as a random variable which is total error term (Koppelman and Bhat, 2006). The logit model is produced by assuming that each ε_{it} is distributed equally and independently. The is also known as Gumble or type I extreme value distribution. On the other hand, the probit models need normal distributions for all unobserved utility components (Train, 2003). Namely, the logit model the errors are independent (covariance $\varepsilon_{it} = 0$), while in the probit model the errors are distributed according to a normal multivariate. Probit models can be applied to panel data with temporally linked errors, can manage random taste fluctuation and they also enable any pattern of replacement which all tree cannot be done by using logit model which is also the simplest and commonly used discrete choice model. Probit models' sole drawback is that they require normal distributions for all unobserved utility components. Normal distributions provide an appropriate approximation of the random components in many circumstances. However, they are unsuitable in some cases and might lead to perverse projections (Train, 2003).

Horowitz et al. (1986) noted equation which X is vector of attributes that describes alternative i, and j; S is also a vector that specifies the characteristics of the individual concerned with i among the choice set C. The utility of an alternative i (U_i), represents a function of the alternatives and individuals' preferences.

$$U_{(Xi,S)} > U_{(Xj,S)} \quad \textbf{(2)}$$

Equation 2 specifies that when the options (alternative set includes) only i and j, the individual will select the alternative i instead of j.

Hensher et al. (2005) stated that the deterministic component of the utility function symbolized a functional relationship between socio-economic characteristics of the individuals, attributes of the alternative and environment and the utility of the specific alternative. In this framework, the deterministic component of the utility of the alternative can be shown as Equation (3):

$$V_i = \beta_{0i} + \beta_{1i} f(X_{1i}) + \beta_{2i} f(X_{2i}) + \cdots + \beta_{Ki} f(X_{Ki}) \quad \textbf{(3)}$$

where, β_{1i} represents the effect of the attribute X1 and alternative i, β_{0i} is defined as alternative specific constant that points out the unobserved effects on utility (Hensher et al., 2005). When all the coefficient of the attributes equal to zero, the unobserved effect on utility can be evaluated.

The probability computation in logit models is performed by using Eq. 4.

$$P_r(i) = \frac{e^{V_i}}{\sum_{j=1}^{J} e^{V_j}} \quad \textbf{(4)}$$

Pr(i) takes a value between 0 and 1, and the sum of the probabilities of each alternative equals to 1. In the MNL, the probability of chosen alternative *i* does not mean the ratio of the deterministic component of alternative *i* to the probability of total alternatives. In the case of a choice between multiple alternatives, the most common method is the MNL. In this case, in the alternative set, there are more than two options. On the other hand, it can be assumed that the error terms are distributed Gumbell. Then, the choice probability of alternative 1 can be estimated with Equation (4) (McFadden, 1974; Ortuzar and Willumsen, 2011; Ben Akiva and Lerman, 1985).

5. Model Application and Estimation Results

Dai et al. (2012) claimed that participants of the PSE generally arrive in a short time before the start. On the contrary, according to the survey data, the spectators arrive to the vicinity of the stadium on average 140 minutes before the start of the game, although these games are organized every two weeks.

According to questionnaire results, in addition to classifying activities as “Eating”, “Entertainment”, and “Other”, another sub-activity class, “Waiting” is also present. However, almost everyone waits before the game, and for that reason it was excluded from the model. The process of the data collection and modelling is presented in Figure 1.

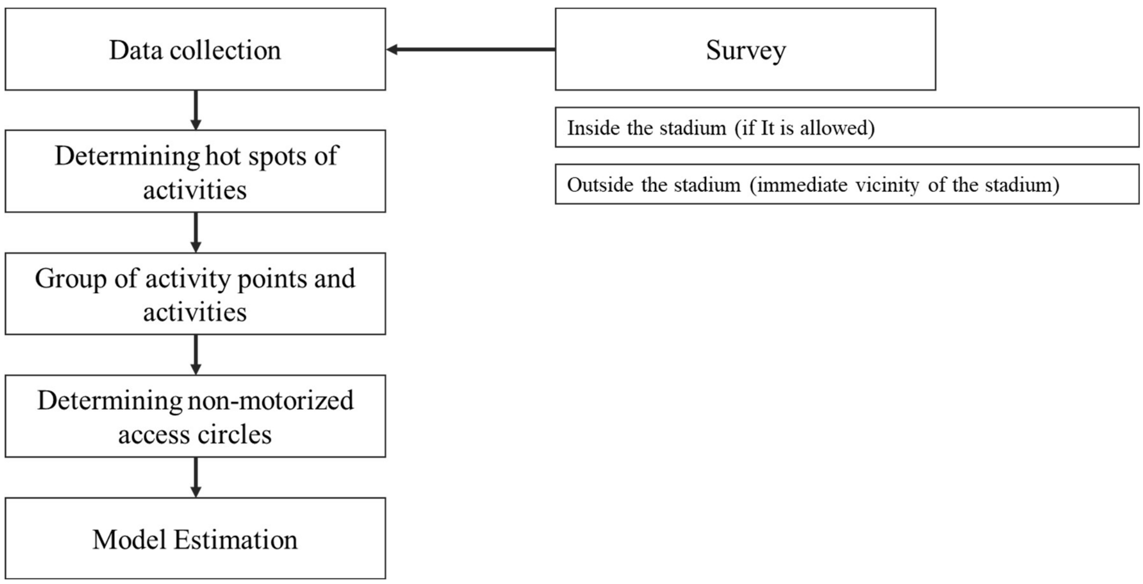

Figure 1: Data collection and modelling process

Possible sub-activity locations were determined by considering each districts of Istanbul as a separate zone. In addition, stadiums were also treated as separate zone. In this case, bird flight distances between the centroids of the zones were taken into account.

Next, as shown in Figure 2, distance segments of 1,000 meters from the stadiums were defined as access circles according to the studies in literature. In the literature, walking distance to various destinations are assumed to take different values. For instance, acceptable walking distance to bus stops could be taken as 400 meters or more (Daniels and Mulley, 2013) or 500 meters (Din et al., 2009). On the other hand, The Guidelines for Providing for Journeys on Foot produced a table of suggested acceptable walking distances, which is reproduced by Wakenshaw and Bunn (2015) shows that commuting/school/sightseeing desirable walking distance is 500 meters, acceptable walking distance is 1.000 meters, and preferred maximum distance is 2.000 meters (Wakenshaw and Bunn, 2015)

In this study, as a result of the fact that spectators use the immediate vicinity of the stadiums as a meeting point, the first segment was defined as 30 meters which usually contains food and beverage places, shopping stores, etc. This 30-meter segment was defined as Zone 1. From thereon, each increasing segment was named with increasing zone name such as Zone 2, Zone 3, and Zone 4. Also, in the calculation of the models, we considered Zone 1 as the reference zone.

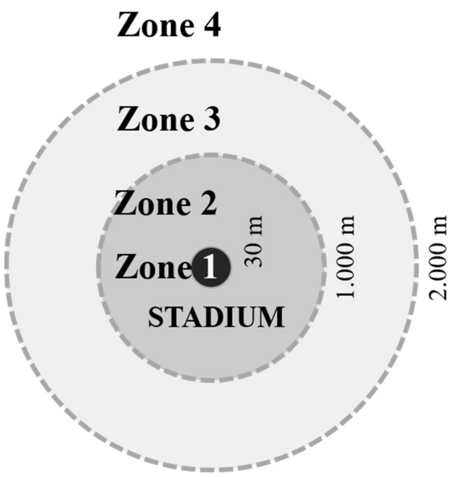

Figure 2: Distance segments (non-motorized access circles)

The figure also points out the impact of a stadium in an ordinary league game, which is repeated every two weeks. Obviously, the spatial distribution of activities or the choice of activity type varies in accordance with proximity to the stadium, as well as the local financial and economic benefits of activities and their costs and durations. An analysis of the activities in the context of the structure given in Figure 1 has the potential to indicate the need to reorganize existing transport and urban policies or to develop new policies when making a new investment such as concert, football or gathering areas.

The location model of sub-activities contains three different sub-models for each activity. In the models, the reference zone is selected as Zone 1. Zone 1 can be defined as the first impact area of the stadium (main activity). The coefficient estimates, their t-statistics, and model performance measure for each model is given in Table 3.

As it is seen in the Table 3 below, the significance of the coefficients at above 90% confidence level is specified with the stars.

- **Activity Duration:** As the duration of the activities increases, the spectators tend to be closer to the stadium. This means the probabilities of the activities in Zone 1 increase with the activity duration. Namely, if the spectators want to spend more time on any of the classified activities, they choose a close location to the stadium. This seems to be logical deduction because individuals cannot take the risk of not being able to catch up with the game due to the prolonging of sub-activity and the possible traffic congestion afterward. Khandker (2009) indicated that a positive coefficient in additional utility component suggests a propensity to schedule longer term activities and vice versa. Likewise, in our study, spectators tend to plan longer duration activities close to the stadiums.
- **Travel Time:** Similarly, the probabilities of the activities in Zone 1 raise with regard to the increase in travel time. The increase in travel time brings the spectators closer to the stadiums. Similarly, individuals want to reach the special event area as soon as possible and they tend to avoid the unexpectedly stuck in traffic and missing the beginning of the game. Especially, the starting time of the games organized on weekdays increases this tendency because of its organization shortly after the end of working hours.
- **Number of Participated Activities:** It is not surprising that the number of activities increases, the probability of the "Eating" and "Entertainment" activities increases in all zones in comparison with reference zone. Generally, the spectators who participate more than one activity tend to prefer zones far from the stadium. On the other hand, for "Other" activities, it is not statistically significant. Those who participate in more than one activity plan their all day according to the game. So, the locations of the all sub-activities are planned before.
- **Time Gap between PSE and Sub-Activity Beginning Time (Time Gap):** It is statistically significant for all zones except the reference and for all activities. The decrease in time difference increases the tendency of individuals to prefer places close to the stadium. It appears rational to deduce that individuals are hesitant to miss the game while choosing the location. It can be said that this is actually a behavior that individuals develop to get the most satisfaction from the sub-activity and the main activity.
- **Weekend:** The variable "weekend" is coded as 1 if the PSE is organized on weekend days, and 0, otherwise. Increasing of the weekend organizations, for "Eating" activities, spectators prefer not to choose the reference zone. For "Entertainment" activity group, it is only statistically significant for Zone 4 and as the weekend PSE organization increases, the tendency of the people to choose the Zone 4 increases. Additionally, organization day of the PSE has statistically no impact on "other" activities. In zones where the weekend variable is significant, it always has positive effect. It can be concluded that this is due to the fact that more time is allocated to the sub-activities at the weekend.

Analyzing the relationship between the predicted model and the base model following results appear. For the estimated activity models, the value of -2LL for Eating, Entertainment, and Other activity groups are 452.860, 506.364, and 120.551, respectively (Eq.5). These -2LL values are higher than the critical chi-square value of the degree of freedom of 15 which is 7.261 with significance at 5%. These results show that the estimated models are improved models. On the other hand, the Pseudo R2 (Eq.6) values also show that the estimated models are strong ones with respect to goodness-of-fit.

$$-2LL = -2(LL_{reference} - LL_{estimated} \quad \textbf{(5)}$$

$$\rho 2 \ (Pseudo - R^2) = 1- (LL_{estimated}/LL_{reference}) \quad \textbf{(6)}$$

Table 3: Model Estimation Results

Utility functions of the zones		*EATING (n=396)*		*ENTERTAINMENT (n=457)*		*OTHER (n=143)*	
Zones	*CHO*	*Coefficient*	*t-stat.*	*Coefficient*	*t-stat.*	*Coefficient*	*t-stat.*
U_{Zone_2}	ASC2	**-15.1122***	-8.16	**-12.9465***	-6.73	*-36.8253*	*0.00*
	Activity Duration	**-.06661***	-7.43	**-.04248***	-5.84	**-.02648***	-3.41
	Travel Time	**-.04444***	-4.98	**-.02375***	-2.54	**-.03785***	-3.45
	Number of Part. Activities	**2.15050***	4.04	**3.24263***	4.69	*0.74429*	*0.88*
	Time Gap	**.05269***	7.47	**.03083***	5.21	**.02466***	3.57
	Weekend	**2.21344***	2.99	*1.29082*	*1.85*	*31.6103*	*0.00*
U_{Zone_3}	ASC3	**-12.5552***	-8.02	**-13.2226***	-9.42	**-5.52116***	-3.34
	Activity Duration	**-.06176***	-7.42	**-.03030***	-6.06	**-.02198***	-3.17
	Travel Time	**-.04564***	-5.93	**-.02536***	-4.19	**-.03522***	-3.63
	Number of Part. Activities	**1.69538***	4.04	**3.45634***	6.74	*0.05031*	*0.07*
	Time Gap	**.05240***	7.72	**.03280***	6.8	**.02530***	3.94
	Weekend	*1.07002*	*1.81*	*0.53486*	*1.16*	*0.28843*	*0.39*
U_{Zone_4}	ASC4	**-17.7518***	-9.41	**-19.3895***	-9.2	**-9.41560***	-5.05
	Activity Duration	**-.07329***	-8.22	**-.05626***	-7.78	**-.02537***	-3.65
	Travel Time	**-.04141***	-5.55	**-.03783***	-4.32	**-.03982***	-4.21
	Number of Part. Activities	**2.43051***	4.49	**3.54538***	4.57	*1.22269*	*1.57*
	Time Gap	**.05905***	8.44	**.04954***	8.52	**.02979***	4.57
	Weekend	**2.42240***	3.36	**2.11989***	2.89	*1.39677*	*1.78*
	LL(M)	-433.011		-439.956		-179.227	
	LL(β)	-206.581		-186.774		-118.951	
	- 2LL	452.860		506.364		120.551	
	ρ2	**0.52**		**0.58**		**0.34**	

LL(M) refers the base model log-likelihood and LL(β) represents the estimated model log-likelihood
* ==> Significance at 5%.

6. Discussion and Conclusion

The transportation master plan model is usually made according to the trips on weekdays. Thus, it is aimed to manage the maximum travel demand that can come during the weekdays with the highest travel demand. Accordingly, various traffic management policies are followed according to different days and times. In such plans, travel demands for weekend days and off – peak hours can also be calculated. However, the travel behavior of individuals is not the same every day. Moreover, if circumstances such as PSEs are viewed as a usual weekend activity without investigating its impact on transportation network, problems in traffic management will arise. The question is how to manage the weekend travel demand with weekday traffic behavior data even some of these main activities are organized on week days. Afterward, is there the same travel demand on every weekend day? The answer is quite clear. Especially, when the issue is a PSE in which individuals pay for it and expect happiness and pleasure. This paper aims to emphasize PSEs on the metropolitan scale, site selection criteria of the sub-activities and proximity analysis of the chosen activities just before the main activity. Because these areas face with the travel and activity demand which are destinations of the last motorized travels of spectators. In order to analyze the proximity of selection area to the stadium and travel behavior of spectators, discrete choice modelling method is used in this study. As a result of this study, for example, spectators do not choose just around the stadiums for the specified activities, but they tend to choose a close point to the stadium for to avoid the risk of missing the beginning of the PSE. Even, food and beverage facilities already are located at just around the stadium, the spectators have a propensity to choose a place that closes to the stadium by 15 minutes distance by walking. Moreover, due to the traffic congestion, as travel time increases the spectators tend to be closer to the stadium for a long time before the game. In another study, Khandker (2009) analyzed the daily activity data collected in Toronto and stated that the average duration of the basic needs (lunch, coffee, etc.) is 92 minutes. However, the duration of the activities in our study is twice the result (184 minutes).

With the development of technology, a number of PSE studies are being carried out. One of the most challenging parts of this kind of study is to collect the data; that is why previous studies concentrated on the major events. We cannot neglect the PSEs that occur every week in our metropolitans where suffer from traffic congestion. Also, generally, the major event studies focused the only center on the main activity because of the availability of the data. However, the main activity should not be the only analyzed point especially for "PSEs" where fanatic fan groups may participate. For the most part of the spectators come together at a point in the impact area of the main activity, then they move to stadiums. In this case, the main issue should not be missed. In this study, how the spectators from far settlements organize their daily activities according to game time on game day and accordingly the location of the chosen sub-activities and their proximities to the stadium are analyzed.

According to the model estimation results, the probability of Eating, Entertainment, and Other activities in Zone 1 which is the reference zone increases with regard to increases in activity duration, and travel time. On the other hand, as the increase in starting time difference between weekend days organized games and sub-activities, the spectators choose distant places due to the sufficient time to do such activities. Otherwise, the spectators do not take any risk to miss the event, so they tend to choose a close place to eat, to have fun, and to do “other” activities if they have not more than enough time. These locations face the initial travel and activity demand. The results obtained from this study can be used as an input for the transportation master plans and urban plans for policy decisions:

- Policies such as road closure and direction of vehicles are done in the immediate vicinity of the stadium. However, the actual vehicle traffic increases where the spectators’ last motorized trips end. Traffic calming policies should be applied in these areas.
- The travel demand should be shifted to different transportation types or different routes and the information of this situation should be shared with the users beforehand. In addition, such information should be shared not only with those who will participate in the special event, but also with those who live in that region, and those who will transit through that area. For this, a special event management strategy

plan should be created. This is especially important in metropolitan cities where traffic congestion is experienced.

- Incentives must be provided for those who come to the places with the last motorized journey by their private vehicle to park and walk or continue with public transportation. Thus, the entry of a private vehicle in places where pedestrian traffic will be intense will be prevented and encouraged for pedestrian travel.
- Temporary pedestrianized areas between the last motorized travel destinations and the stadium and temporary commercial areas can be created if it is needed.

References

Ben Akiva, M., Lerman, S. (1985) Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press. Cambridge, Massachusetts, USA.

Bhat, C.R., Koppelman, F.S. (2003) "Activity-Based Modeling of Travel Demand", In: Hall, Randolph (Ed.) Handbook of Transportation Science, Springer, New York.

Bowman, J.L., Ben-Akiva, M.E. (2000) "Activity-based disaggregate travel demand model system with activity schedules", Transportation Research Part A, 35, pp. 1-28.

Clark, J., Kearns, A., Cleland, C. (2016) "Spatial Scale, Time and Process in Mega-events: The Complexity of Host Community Perspectives on Neighborhood Change", Cities, 53, pp. 87-97.

Cook, R. A., Yale, L. J., Marqua, J. J. (2010) Tourism: The Business of Travel, Pearson Education Limited: Pearson Prentice Hall. United Kingdom.

Dai, L., Gu, J., Sun, Z., Qiu, H. (2012) "Study on Traffic Organization and Management Strategies for Large Special Events", International Conference on System Science and Engineering, June 30 – July 2, 2012, Dalian, China.

Daisy, N.Z., Millward, H., Liu, L. (2018) "Trip chaining and tour mode choice of non-workers grouped by daily activity patterns", Journal of Transport Geography, 69, 150–162.

Daniels, R., Mulley, C. (2013) "Explaining walking distance to public transport: The dominance of public transport supply", Journal of Transport and Land Use, 6(2), pp. 5-20.

Day, N. (2008) The Joint Modelling of Trip Timing and Mode Choice, Master of Applied Science thesis, University of Toronto, Canada.

Din, M.A.M., Karim, M.R., Saritja, P. (2009) "The Aspect of Walking Accessibility in The Development gf GIS-Based Transit System Modelling in Kuala Lumpur", Pre 24th International Cartographic Conference, Santiago de Chile, Chile.

Dunn, W. (2007) "Managing Travel for Planned Special Events Handbook: Executive Summary", FHWA-HOP-07-108, Department of Transportation, Washington D.C, USA.

Elmorssy, M., Tezcan, H. O. (2019) "Application of Discrete 3-level Nested Logit Model in Travel Demand Forecasting as an Alternative to Traditional 4-Step Model", International Journal of Engineering (IJE): Transactions A: Basics, 32 (10), pp. 1416-1428.

Frantzeskakis, J., Frantzeskakis, M. (2006) "Athens 2004 Olympic Games: Transportation Planning, Simulation and Traffic Management", ITE Journal, 76 (10), pp. 26–32.

Frawley, S., Hoven, P.V. (2015) "Football participation legacy and Australia's qualification for the 2006 Football World Cup", Soccer & Society, 16, (4), pp. 482-492.

Getz, D. (1997) "Event Tourism: Definition, evolution, and research", Tourism Management, 29, pp. 403-428.
Giampiccoli, A., Lee, S., Nauright, J. (2015) "Destination South Africa: comparing global sports mega-events and recurring localised sports events in South Africa for tourism and economic development", Current Issues in Tourism, 18(3), pp. 229-248.
Khandker, H. (2009) "Investigating multiple activity participation and time-use decisions by using a multivariate Kuhn-Tucker demand system model", Transportation Letters, 1(4), pp. 257-269.
Hensher, D.A., Rose, J.M., Greene, W.H. (2005) Applied Choice Analysis: A Primer, Cambridge University Press. United Kingdom.
Horowitz, J.L., Koppelman, F.S., Lerman, S.R. (1986) "A Self-Instructing Course in Disaggregate Mode Choice Modelling", Federal Highway Administration Department of Transportation, Washington, USA.
Koppelman, F.S., Bhat, C. (2006) "A Self Instructing Course in Mode Choice Modelling: Multinomial and Nested Logit Models", U.S. Department of Transportation Federal Transit Administration, Washington, DC, USA.
Kuppam, A., Copperman, R., Rossi, T., Livshits, V., Vallabhaneni, L., Brown, T., DeBoer, K. (2010) "Innovative Methods to Collecting Data for Special Events and Modelling Travel Related to Special Events", Transportation Research Record Journal of the Transportation Research Board, 2246 (1), pp. 24-31.
Kuppam, A., Copperman, R., Lemp, J., Rossi, T., Livshits, V., Vallabhaneni, L., Jeon, K., Brown, E. (2013) "Special events travel surveys and model development", Transportation Letters, 5(2), pp. 67-82.
Latoski, S.P., Dunn, W.M., Wagenblast, B., Randall, J., Walker, M.D. (2003) "Managing travel for planned special events" Department of Transportation, Washington D.C, USA.
Li, Y., Wang, X., Sun, S., Ma, X., Lu, G. (2017) "Forecasting short-term subway passenger flow under special events scenarios using multiscale radial basis function networks", Transportation Research Part C, 77, pp. 306–328.
McFadden, D. (1974) "The Measurement of Urban Travel Demand", Journal of Public Economics, pp. 303-328.
Ortuzar, J. D., Willumsen, L. G. (2011) Modelling Transport (4th Edition), A John Wiley and Sons, Ltd., Publication, United Kingdom.
Shakibaei, S., Tezcan, O. H., Ogut, S. (2014) "Evaluating Transportation Preferences for Special Events: A Case Study for a Megacity, Istanbul" EWGT2013 – 16th Meeting of the EURO Working Group on Transportation. Procedia - Social and Behavioral Sciences, 111, pp. 98 – 106.
Shin, J., Lyu, S.O. (2019) "Using a discrete choice experiment to estimate spectators' willingness to pay for professional baseball park sportscape", Sport Management Review, 22, pp. 502-512.
Skolnik, J., Chami, R., Walker, M. (2008) "Planned Special Events – Economic Role and Congestion Effects", FHWA-HOP-08-022. Department of Transportation, Washington D.C, USA.
Train, K. (2003) Discrete choice methods with simulation, The Press Syndicate of the University of Cambridge, United Kingdom.
Wakenshaw, G. Bunn, N. (2015) "How far do people walk?" Presented at the PTRC Transport Practitioners' Meeting, 1-2 July, London.

Yaun, F., Giese, K., Lew, K. (2009) "A Multiclass Dynamic Traffic Assignment Model for Special Events Management", 12th TRB National Transportation Planning Applications Conference, Texas, USA.
Zagidullin, R. (2017) "Model of Road Traffic Management in the City during Major Sporting Events", Transportation Research Procedia, 20, pp. 709-716.

Acknowledgements

The authors wish to thank to Istanbul Technical University Scientific Research Projects Coordination Unit (ITU BAP) for their support. Moreover, the authors express their gratitude to the referees for their helpful remarks and suggestions, which have significantly improved the paper's readability and quality.