Studying Differences of Household Weekday and Weekend Activities

A Duration Perspective

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A desired activity-based travel demand modeling framework should be able to address both weekday and weekend activities. However, a literature review shows that previous research efforts have mostly focused on weekday, not weekend, activities, and that little or no research exists to quantify the differences between the two. The best knowledge to date is limited to weekday and weekend activities that start at different times of the day and have different participation rates. This paper aims to fill the gap by studying the differences between weekday and weekend activities in Calgary, Canada, in terms of participation rates, starting times, duration, and inferred location choices. First, statistics related to these attributes were computed for 10 types of weekday and weekend activities (these were found to differ). Second, log-rank and Wilcoxon tests were used to prove further that common types of weekday and weekend activities tend to follow different survival functions. Third, best-fit duration models were explored for each type of weekday and weekend activity and compared with each other. It was found that Weibull and log-normal were chosen as the best-fit models for nearly all weekday and weekend activities. The best-fit duration models for the same types of weekday and weekend activities (e.g., shopping) were found to be different in either underlying distribution or estimated parameters. This study clearly shows that the weekend activities differ from their weekday counterparts and suggests that they be treated separately in activity-based modeling frameworks.

Activity-based travel demand modeling is relatively new and has not been widely used in practice (*1, 2*). It has many advantages over traditional trip-based approaches, such as richness, theoretical elegance, and intuitive implementation with microsimulation. However, it requires significantly more financial and personal resources for collecting data and carrying out detailed analysis. Fortunately, advances in information technology, such as object-oriented database design, high-performance computing, and geographic information systems, have made onerous data collection, management, and processing easier, and model development costs have accordingly been reduced. Within activity-based modeling frameworks, duration has stood out as one of the important themes, mainly because it is an inherent part of any activity. Once activity sequence, duration, and location choices are determined, travel can be captured as the "induced" demand triggered by the other activities.

The literature indicates that almost all studies have investigated weekday activities and related travels (*3*), with less attention having been placed on weekends (*4–6*). The logic may be that high travel demand at morning and evening peak hours on weekdays result in frequent traffic congestion and thus warrants special attention. However, as travel demand increases and infrastructure construction is constrained, traffic congestion takes place in recreational areas, major shopping centers, sports arenas, and bridges in many big cities over weekends (*7*). Moreover, real-time traffic operation and management offered by Intelligent Transportation Systems (ITS) requires travel demand information from weekends. Accordingly, travel demand modeling on weekdays and weekends is needed at both the planning and operation levels, and they should be integrated into one modeling framework. This challenges traditional approaches of analyzing weekday and weekend activities separately and warrants a study that would investigate them together.

Within the existing literature on modeling weekday and weekend activities, no study has been found investigating the differences between the two. The knowledge is generally limited to the fact that weekday and weekend activities have different starting times and participation rates (*8*). Therefore, this paper is aimed at empirically quantifying the differences between weekday and weekend activities in terms of their participation rates, starting times, duration, and inferred location choices, with a focus on their duration properties. Various statistical and visual techniques are used to show the differences.

The rest of the paper is organized as follows. First, a literature review of duration modeling applications for weekend and weekday activity is presented, the data used in this study are briefly introduced, and a general picture of 10 weekday and weekend household activities is presented. These activities are compared in terms of participation rates, starting times, and duration. The analyses are then continued by choosing the best-fit hazard functions for each type of weekday and weekend activity. The best-fit models are evaluated and compared with each other. Finally, an empirical example and a few conclusions are presented.

DURATION MODELING OF WEEKEND AND WEEKDAY ACTIVITY PATTERNS

A review of the literature indicates that limited efforts have been made toward modeling activity durations, even though they form an integrated part of any activity-based framework. For example, Kitamura (*9*) mentioned that only Weibull distributions are considered for exclu-

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sively modeling durations of 18 daily activities (such as sleep, personal care, child care, meals, domestic chores, work and work-related school and study) in a framework called PCATS. Recent developments in the area consist of proposing a general framework for modeling workers' or commuters' activity and travel patterns (*10–12*), but none of them explicitly model the durations of considered activities. Because there is so little information in this area, the practitioners used observed duration distributions in their models (*13*).

Among the scare literature for weekend activity duration modeling, a group of scholars at the University of Texas at Austin stood out and contributed a few studies (*3–6*). In particular, Lockwood et al. provided a comprehensive exploratory analysis of nine categories of weekend activities, including average frequency and durations, time of day of travel, model of travel by trip purpose, trip distance by purpose, total volume of travel by trip purpose, sequencing of activity episodes, activity episode chaining, and activity purpose of the first and last out-of-home episode of the day (*3*). The researchers basically presented a comprehensive view of weekend activities in the Bay Area by a series of statistical analyses, but no attempts were made to specify duration models for individual activities. Although Bhat and Srinivasan (*5*) and Sall et al. (*6*) outlined the methodologies of duration modelling in their weekend activity analysis framework, no statistical results were provided.

There are a number of recent studies applying duration models to nonwork activities (though not necessarily weekend activities). For instance, Ettema et al. (*14*) used competing risk hazard models to model the activity choice, timing, sequencing, and duration of 39 students at the Eindhoven University of Technology in the Netherlands. Chu (*15*) used a Type II Tobit model to model workers' daily nonwork activity durations with 1997–1998 New York household survey data. Hamed and Mannering (*16*) estimated travel time from work to home and activity durations with ordinary least squares regression and three-stage least squares regression. The corrected R^2 of 0.11 was reported for the ordinary least squares regression, and 0.188 for the three-stage least squares regression. Mannering and Hamed (*17*) used a Weibull-based duration model for estimating commuters' work-to-home departure delay time in Seattle. The choice of the Weibull distribution is based on the authors' finding that the end of a departure delay can be viewed as being induced by any one of a number of random factors, such as decrease in homeward traffic congestion, boredom with the activity undertaken, completion of activity undertaken, and so forth. They argued that because the end-of-departure delay depends on the shortest time to the occurrence of one of these random factors, it should follow a distribution of the smallest extreme, and that the Weibull distribution is therefore appropriate (*17*). They achieved a standard error of 0.148 for the duration parameter estimates.

STUDY DATA AND PRIMARY ANALYSES

A large-scale household activity survey was completed in the city of Calgary, Alberta, Canada, in late 2001 and early 2002 (*18*). The purpose of the survey was to collect data for both short-term traffic operational analysis and long-term transportation planning. The data provide excellent opportunities for analyzing weekday and weekend activities and related travel behaviors and are expected to provide insights for future policy analyses.

The data include detailed socioeconomic information about the individuals being surveyed and the attributes of the executed activities, such as personal type, employment status (full-time or part-time), annual income level, gender, age, household size (persons in household), driving capability (licensed or not), activity type, activity durations (in minutes), and starting and ending times for each activity. The 10 activities investigated in this study include the following: (*a*) travel-related activity (e.g., dropping off or picking up a person), (*d*) working, (*e*) schooling, (*f*) shopping, (*i*) socializing, (*j*) eating, (*k*) entertainment, (*m*) exercise, (*n*) religious activities, and (*z*) out-of-town travel. The activity types and their labels were defined during the survey and are directly used here. Approximately 13,000 weekday and weekend records are used in this study.

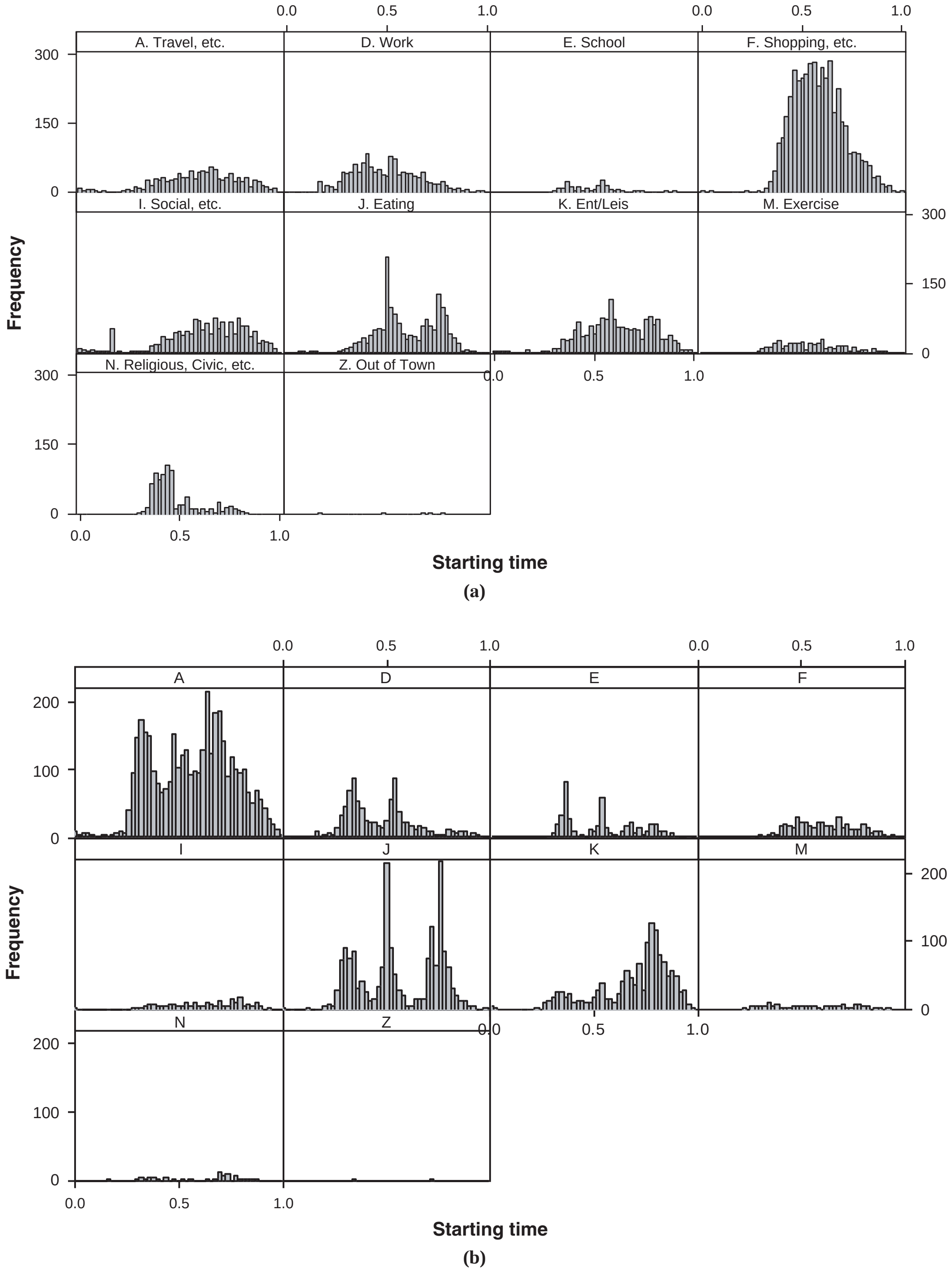
Figure 1 shows the (*a*) weekend and (*b*) weekday household activity patterns. The frequencies of each type of activity are plotted against their starting time of the day, with 0.0 representing time before 12:00 noon, 0.5 representing 12:00 noon, and 1.0 representing time after 12:00 noon. It is clear from Figure 1*a* that, except for the religious and civic activity, the majority of all the other weekend activities start in the afternoon (i.e., after the middle point of 0.5—12:00 noon) and that there is usually only one afternoon peak for the weekend activities. For example, the weekend shopping, socializing, and entertainment and leisure activities show exactly such patterns. In contrast, Figure 1*b* shows that, in general, weekday activities start in the morning and that there are both morning and afternoon peaks for work- and school-related activities. Comparisons made between Figure 1*a* and 1*b* indicate that the amount of individual activities is consistent with the expected weekly periodicity (the different scales used for weekend and weekday activity frequencies should be noted). For example, there are many more work- and school-related activities that take place during weekdays, but fewer shopping, religious, socializing, and entertainment activities; the weekends show the opposite pattern. The weekend activity patterns indicate that a corresponding high traffic demand will be introduced over a short period in the afternoon. This could potentially challenge weekday-based urban traffic management systems, and a distinct traffic operation strategy may be required.

Figure 2 shows (*a*) weekday and (*b*) weekend activity participation rates. It should be noted that, in Figure 2, the minor weekday and weekend activities with a participation rate less than 3% are placed in the right smaller pies. Figure 2 reconfirms the conclusion from Figure 1 that there are more travel and work- and school-related activities during the weekdays, whereas the weekends are distinguished by more shopping and socializing and leisure-related activities. For example, the total participation rate for work and school during the weekdays is 13.8%, but this rate drops to 3.5% on the weekends. The total participation rate for typical weekend activities (including shopping, socializing, and entertainment and leisure) is only 21.5% during the weekdays, but the rate increases to more than 33% over the weekends. The activity participation rates shown here imply different location choices between weekdays and weekends, as people would have to travel to different destinations to fulfill their goals.

Table 1 compares the mean, median, and the 75th percentile durations for the same types of weekday and weekend activities. The percent difference (PD) is calculated using the following equation:

$$\text{PD} = \frac{\text{weekend statistic} - \text{weekday statistic}}{\text{weekday statistic}} \times 100\% \qquad (1)$$

The results in Table 1 show that weekday travel, school, and out-of-town activities usually last longer than their weekend counterparts, but that all the other activities tend to be shorter. The differences are usually within 20% of each other for corresponding weekday and weekend travel, work, school, shopping, eating, entertainment and leisure, and exercise activities. However, there are much larger differences for socializing, religious, civil, and out-of-town activities. The



(a)

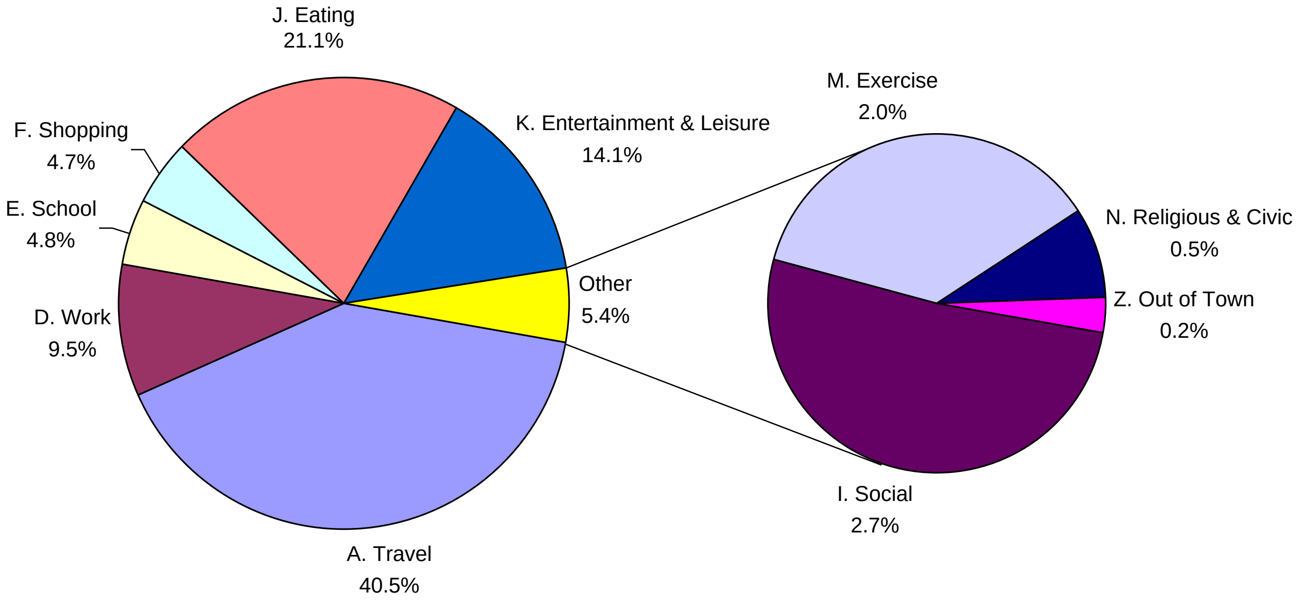
(b)

FIGURE 1 Comparison of household (*a*) weekend and (*b*) weekday activity patterns.

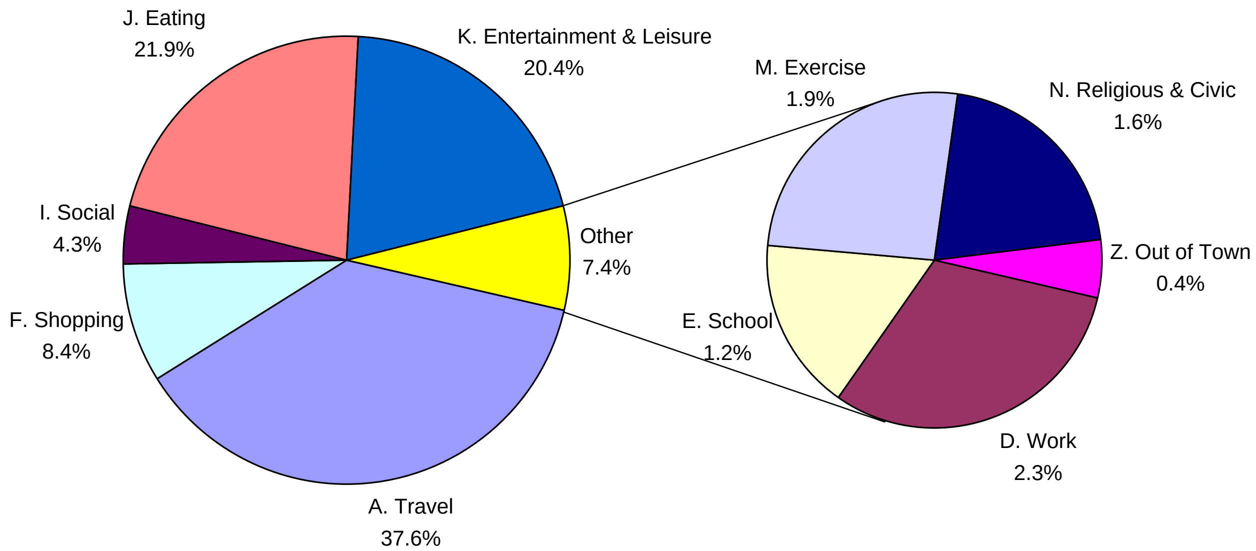
differences are all more than 30% to 40%, with some as high as 76%. Such large differences emphasize the fact that these are typical weekend activities. Another finding from Table 1 is that there are large differences between the mean duration levels of different activities. For example, the mean duration of travel-related activities (drop-by and others) is 18 min, whereas working activities on average last for more than 200 min. The large difference emphasizes the fact that different activities should be modeled separately.

STUDY RESULTS

The statistical analyses in the previous section show that weekday and corresponding weekend activities are different in terms of their starting times, duration, participation rates, and, consequently, location choices. This may imply that an activity-based modeling framework needs to address them separately and thus would unavoidably increase modeling complexity. Therefore, an interesting question is raised:



(a)



(b)

FIGURE 2 Calgary (*a*) weekday and (*b*) weekend activity participation rates.

Do a given type of weekday and weekend activities follow a similar or the same type of underlying distributions and can they be combined and modeled together? The first part of this section addresses this question.

Kaplan–Meier tests are used to check whether corresponding weekday and weekend activities follow the same survival function. Basically, this involves visually comparing the survival functions of a given type of weekend and weekday activities and calculating the following two statistics: log-rank and Wilcoxon. The log-rank and Wilcoxon tests are nonparametric approaches used to compare whether two samples follow a same underlying distribution (*19*). Figure 3 shows such a test for comparing weekday and weekend shopping durations. It can be seen that the two patterns meet each other quite well at the each end but show significant differences in the middle range, especially from 30 to 200 min. During that period, the weekend pattern clearly has longer durations than its weekday counterpart. The log-rank and Wilcoxon statistics shown in Figure 3 also emphasize that the two distributions are significantly different at the 95% confidence level because the *p*-values are all less than 0.05. Table 2 lists the log-rank and Wilcoxon statistics for all 10 pairs of weekday and weekend activities considered in this study. The chi-square statistic for either the log-rank or the Wilcoxon test is significant at the 95% confidence level in nine out of 10 cases. This observation further emphasizes that the distributions of weekday and weekend activity durations are different. It is interesting to note that the weekday and weekend working durations are not significantly different; this fact is supported by corresponding log-rank and Wilcoxon statistics of 0.071 and 0.418, respectively.

TABLE 1 Percentage Difference for Weekday and Weekend Activity Durations

Activity	Statistics	Weekday	Weekend	PD
A. Travel, etc.	Mean	18.7	18.1	−3.5
	Median	15.0	15.0	0.0
	P75	25.0	20.0	−20.0
D. Work	Mean	229.4	249.6	8.8
	Median	210.0	227.5	8.3
	P75	300.0	369.0	23.0
E. School	Mean	175.3	148.7	−15.2
	Median	150.0	120.0	−20.0
	P75	215.0	197.5	−8.1
F. Shopping	Mean	44.9	50.3	11.9
	Median	30.0	35.0	16.7
	P75	60.0	69.5	15.8
I. Sociality	Mean	82.0	128.3	56.5
	Median	60.0	105.0	75.0
	P75	110.0	165.0	50.0
J. Eating	Mean	36.6	42.0	14.9
	Median	30.0	30.0	0.0
	P75	45.0	60.0	33.3
K. Entertainment & leisure	Mean	125.4	143.9	14.7
	Median	110.0	120.0	9.1
	P75	180.0	210.0	16.7
M. Exercise	Mean	64.0	76.0	18.7
	Median	60.0	60.0	0.0
	P75	89.0	90.0	1.1
N. Religious, civic, etc.	Mean	63.9	112.8	76.5
	Median	20.0	105.0	425.0
	P75	79.3	130.0	64.0
Z. Out of town	Mean	772.4	492.1	−36.3
	Median	735.0	425.0	−42.2
	P75	962.5	720.0	−25.2

P75 = 75th percentile.

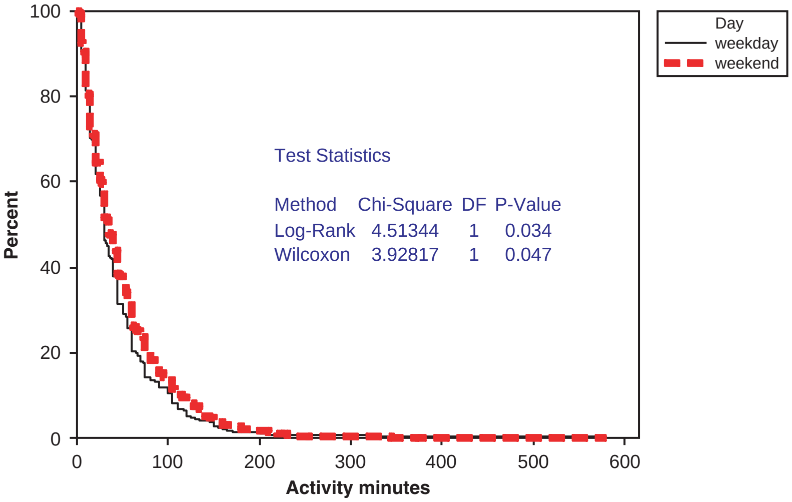
The above analyses show that, in general, pairs of weekday and weekend activity durations distribute differently and suggest that they should be modeled separately (except for the working activity). Another interesting problem is to study how different the pairs are in terms of their best-fit duration models. Would their best-fit models be very different in terms of model type (e.g., Weibull versus log-normal) and parameters?

TABLE 2 Statistics for Log-Rank and Wilcoxon Tests

	Log-Rank		Wilcoxon	
Activity	Chi-Square	*p*-Value	Chi-Square	*p*-Value
A. Travel, etc.	4.73	0.030	6.74	0.009
D. Work	3.25	0.071	0.65	0.418
E. School	3.47	0.062	5.70	0.017
F. Shopping	4.51	0.034	3.93	0.047
I. Sociality	35.88	0.00	45.58	0.00
J. Eating	46.89	0.00	47.96	0.00
K. Ent. & leisure	30.41	0.00	24.99	0.00
M. Exercise	4.00	0.045	1.65	0.199
N. Religious, civic, etc.	35.68	0.00	90.53	0.00
Z. Out of town	3.90	0.048	7.89	0.005

The analyses are done by fitting 11 parametric models against each weekday and weekend activity pair, identifying the best-fit models, and comparing them. The following distributions are tested: Weibull, log-normal, exponential, log-logistic, three-parameter Weibull, three-parameter log-normal, two-parameter exponential, three-parameter log-logistic, smallest extreme value, normal, and logistic. The goodness-of-fit of individual models is evaluated with adjusted Anderson–Darling test statistics (AD values in Table 3) and correlation coefficients (COR in Table 3). The criterion for choice of best-fit model is to select the distribution with the lowest AD value or the highest COR value, or both (*19*).

Table 3 shows the analysis results. For illustration purpose, the AD and COR values for the best-fit models are highlighted with bold fonts. From Table 3, it can be seen that a relatively high level of goodness-of-fit is achieved, shown by universally high COR values (greater than 0.98). The AD values vary greatly from as low as less than 1 to more than 500, depending on which distribution is selected and how many observations are available for fitting. In general, AD values greater than 2.5 indicate a lack of fit, and they are observed for nearly half of the cases (*20*). Detailed analysis indicates that this results from imputed durations, as many observations were reported as integer spells (e.g., 1, 2, 5, or 10 min). The highly



Test Statistics

Method	Chi-Square	DF	P-Value
Log-Rank	4.51344	1	0.034
Wilcoxon	3.92817	1	0.047

FIGURE 3 Kaplan–Meier test for weekday and weekend shopping activity.

TABLE 3 Goodness-of-Fit Tests for Individual Weekday and Weekend Activities

Distribution	Weekday/ Weekend	Travel Related		Work		School		Shopping		Sociality		Eating		Entertainment–Leisure		Exercise		Religious, etc.		Out of Town	
		AD	COR	AD	COR	AD	COR	AD	COR	AD	COR	AD	COR	AD	COR	AD	COR	AD	COR	AD	COR
Weibull	Weekday	63.02	0.97	6.28	0.99	3.71	0.99	6.21	0.97	**0.52**	**0.99**	76.09	0.96	5.35	0.99	1.81	0.98	10.83	0.89	1.26	0.97
	Weekend	103.15	0.96	1.434	0.99	0.87	0.99	9.58	0.98	0.68	1.00	84.05	0.96	5.27	1.00	4.01	0.96	3.38	0.97	**0.71**	**0.99**
Log-normal	Weekday	42.01	0.99	25.49	0.95	6.29	0.98	1.77	0.99	3.63	0.97	42.33	0.98	14.65	0.98	2.35	0.98	2.95	0.96	1.01	0.99
	Weekend	53.07	0.98	6.13	0.94	1.10	0.99	3.75	0.99	4.97	0.97	45.06	0.98	21.10	0.98	0.97	0.99	3.46	0.94	1.70	0.97
Exponential	Weekday	209.26	*	67.27	*	37.37	*	4.52	*	0.86	*	298.78	*	90.89	*	26.84	*	22.04	*	5.99	*
	Weekend	232.23	*	10.29	*	6.41	*	5.55	*	9.79	*	308.36	*	136.19	*	14.76	*	29.89	*	5.95	*
Log-logistic	Weekday	48.39	0.99	24.89	0.95	6.34	0.97	2.86	0.99	3.64	0.97	43.79	0.98	19.50	0.98	2.68	0.98	3.57	0.96	1.05	0.98
	Weekend	52.52	0.98	5.81	0.94	1.36	0.98	7.06	0.98	4.64	0.97	49.05	0.98	25.45	0.97	**0.95**	**0.99**	2.42	0.96	1.95	0.96
3-parameter Weibull	Weekday	43.21	0.98	6.40	0.99	3.18	0.99	2.59	0.98	0.58	0.99	64.72	0.97	**4.83**	**0.99**	**1.35**	**0.99**	3.52	0.96	**0.99**	**0.99**
	Weekend	77.79	0.97	**0.84**	**1.00**	**0.51**	**1.00**	6.10	0.98	**0.67**	**1.00**	73.35	0.96	**4.77**	**1.00**	1.99	0.98	3.87	0.97	0.78	0.99
3-parameter log-normal	Weekday	**35.61**	**0.99**	**4.76**	**0.99**	**2.78**	**0.99**	**1.50**	**0.99**	0.99	0.99	**42.18**	**0.98**	7.23	0.99	1.50	0.99	**1.55**	**0.98**	1.01	0.99
	Weekend	**50.93**	**0.98**	1.22	0.99	0.66	0.99	**3.23**	**0.99**	0.95	0.99	**45.85**	**0.98**	9.33	0.99	0.97	0.99	1.89	0.98	0.80	0.99
2-parameter exponential	Weekday	140.34	*	64.33	*	31.13	*	10.30	*	2.86	*	252.10	*	86.41	*	14.55	*	13.57	*	1.53	*
	Weekend	167.58	*	10.02	*	3.58	*	3.34	*	9.00	*	266.61	*	130.67	*	6.77	*	26.20	*	3.57	*
3-parameter log-logistic	Weekday	46.18	0.99	6.83	0.98	3.27	0.98	2.86	0.99	1.95	0.98	44.17	0.98	16.28	0.98	2.05	0.98	1.74	0.98	1.05	0.98
	Weekend	52.23	0.98	2.42	0.98	1.15	0.99	7.07	0.98	2.16	0.99	50.14	0.98	21.72	0.98	0.98	0.99	**1.27**	**0.99**	1.14	0.98
Smallest extreme value	Weekday	455.84	0.67	90.13	0.89	60.49	0.85	71.22	0.68	36.03	0.71	262.12	0.79	131.90	0.86	12.10	0.88	24.29	0.51	1.77	0.94
	Weekend	519.70	0.66	21.25	0.89	13.46	0.84	131.05	0.78	52.77	0.84	261.01	0.79	172.64	0.87	22.19	0.75	29.04	0.83	5.03	0.92
Normal	Weekday	161.42	0.78	14.63	0.97	12.53	0.95	24.34	0.80	11.41	0.83	92.95	0.89	26.22	0.96	2.82	0.96	15.68	0.64	1.09	0.98
	Weekend	221.91	0.78	4.12	0.97	3.38	0.94	37.32	0.90	11.31	0.94	96.24	0.89	34.08	0.96	7.85	0.86	6.82	0.92	1.13	0.98
Logistic	Weekday	152.49	0.81	14.52	0.96	11.38	0.95	23.21	0.82	10.91	0.84	94.64	0.90	30.28	0.95	3.00	0.96	14.82	0.67	1.12	0.97
	Weekend	205.59	0.81	5.02	0.96	3.27	0.94	37.06	0.90	11.38	0.94	98.78	0.90	43.45	0.96	6.57	0.88	5.53	0.93	1.35	0.97

imputed durations result in large AD values as Anderson–Darling tests emphasize more the fit of the tails (*19*).

The resulting best-fit models selected for the 10 weekend activities are as follows: three-parameter log-normal for travel-related activity, shopping, and eating; Weibull or three-parameter Weibull for work, school, socializing, entertainment and leisure, and out-of-town activity; and log-logistic or three-parameter log-logistic for the exercise and religious activity. The Weibull model, and especially the three-parameter Weibull, are identified as being the most applicable models, followed by log-normal and log-logistic.

The best-fit models selected for the 10 weekday activities are also presented in Table 3: three-parameter log-normal for travel-related activity, work, school, shopping, eating, and religious activity; and Weibull or three-parameter Weibull for the remaining activities, which include socializing, entertainment and leisure, exercise, and out-of-town activities. In contrast to the results for the weekend activities, only log-normal and Weibull models are selected as best-fit.

In only four out of 10 cases, the weekday activities have the same best-fit model forms as their weekend counterparts. In the other six cases, the best-fit function forms are different. For example, log-logistic is chosen as the best-fit model for the weekend exercise activity, but for the weekday activity, the three-parameter Weibull model is selected. In addition, the estimated parameters are found different in all cases.

The best-fit models selected above are further proved by visually comparing the fitted lines with observed cumulative distribution functions. Figure 4*a* shows such an example for the weekend shopping activity. The three-parameter log-normal model fits the observed durations very well. Figure 4*b* shows the probability density function (PDF), the probability plot, the survival function, and the hazard function (HF). The bell-shaped hazard function curve clearly supports the assertion that either a log-normal or a log-logistic model should be used. The data show that most people have a shopping duration of less than 75 min, as the area under the PDF greater than this value is very small, and the survival rate very low (less than 20%). The highest hazard rate for discontinuing the activity is found about 0.03 at 25 min. The HF shows a rapid increasing trend from the starting point to the peak and a fairly flat diminishing rate after that point. Such an HF pattern indicates that people with a shopping duration of less than 25 min are more sensitive to the time spent because the probability of abandoning the activity increases very quickly as the time elapses. In contrast, those who stay longer than 25 min tend to stay longer as their hazard rates begin to drop. The "probability plot" on the same figure (in the upper right corner of Figure 4*b*) indicates a good fit between the theoretical function (line) and the observed durations (dots). However, a noticeable deviation at the lower left corner can be observed. Close examination of the data indicates that it results from the "imputed nature" of reported durations mentioned above.

Attempts at testing semiparametric models were abandoned because the competing parametric models were found to have a high degree of fit. In such cases, parametric approaches are preferred because they are more accurate and better understood by practitioners (*21*).

CONCLUDING REMARKS

The credibility of transportation planning has been significantly improved through detailed study of household activities and induced travel patterns. Previous research has been focused on weekday activities, with little emphasis placed on their weekend counterparts. This paper empirically quantifies the differences between the two in the context of the city of Calgary, Canada. This study compares 10 pairs of household weekday and weekend activity patterns in terms of their participation rates, starting times, duration, "inferred" location choice, and best-fit parametric models.

Pattern analyses show that weekend activities are quite different from weekday activities. There is only one peak for most of weekend activities (e.g., shopping), and the peak is usually around or after 12:00 noon. On the contrary, most weekday patterns show two peaks: one in the morning and one in the afternoon. Such a finding confirms the distinctions between weekday and weekend travel patterns and suggests that different traffic operation strategies may have to be applied.

A comparison between weekday and weekend activity participation rates shows that there are more travel and work and school-related activities during the weekdays; in contrast, the weekends are distinguished by more shopping and socializing and leisure-related activities. For example, the participation rate for activities not related to work or school (including shopping, socializing, and entertainment and leisure) represents only 21.5% of the total during the weekdays, but jumps to 33% on the weekends. The different activity participation rates over weekdays and weekends imply shifts in people's location choices and thus their travel patterns. Significant increases in activities not related to work or school during the weekends suggest that more attention should be paid to these activities' related travels.

Descriptive statistics such as mean, median, and the 75th percentile are used to evaluate the differences between weekday and weekend duration patterns. It is found that there are large differences. In general, weekday school, travel-related, and out-of-town activities are longer than those executed over the weekends. The other activities tend to last longer during the weekends.

The fact that weekday activities and their weekend counterparts tend to have different durations is further proved with the Kaplan–Meier nonparametric tests. The log-rank and Wilcoxon test statistics are significant at the 95% confidence level in most cases and reject the hypothesis that weekday activities and their weekend counterparts follow the same duration distributions.

Eleven parametric duration models are used to fit the 10 types of weekday and weekend activities. It is found, in general, that a high level of goodness-of-fit is achieved across all types of activities. The best-fit models identified for the weekday and weekend activities are Weibull, log-normal, and log-logistic. The best-fit models for each weekday and weekend activity pair are found to be different in model types and parameters, or both. Study results show that it may not be appropriate to apply a "universal" duration model (e.g., Weibull) to all activity types.

The duration models developed here will be used in the Calgary household travel model framework. The aim is to replace previous "static" duration models that were based on weighted samples from observed durations. The models developed in this study explicitly consider many characteristics of individuals and activities, but they do not incorporate those variables by which important transportation policy analyses can be made, such as transit fare and waiting time. For example, if the city government could provide transit service with much lower fares and shorter waiting times, it could be assumed that people would travel more frequently to visit more locations. Therefore, they would stay for a shorter period of time at any given location. Currently, this assumption is limited by the data used; future research should include the variables of transit fare and waiting time into the analysis once this information is available. Another issue identified during this research is the "rounding" of reported durations. These "imputed" durations result in deteriorated fit. It is expected that the

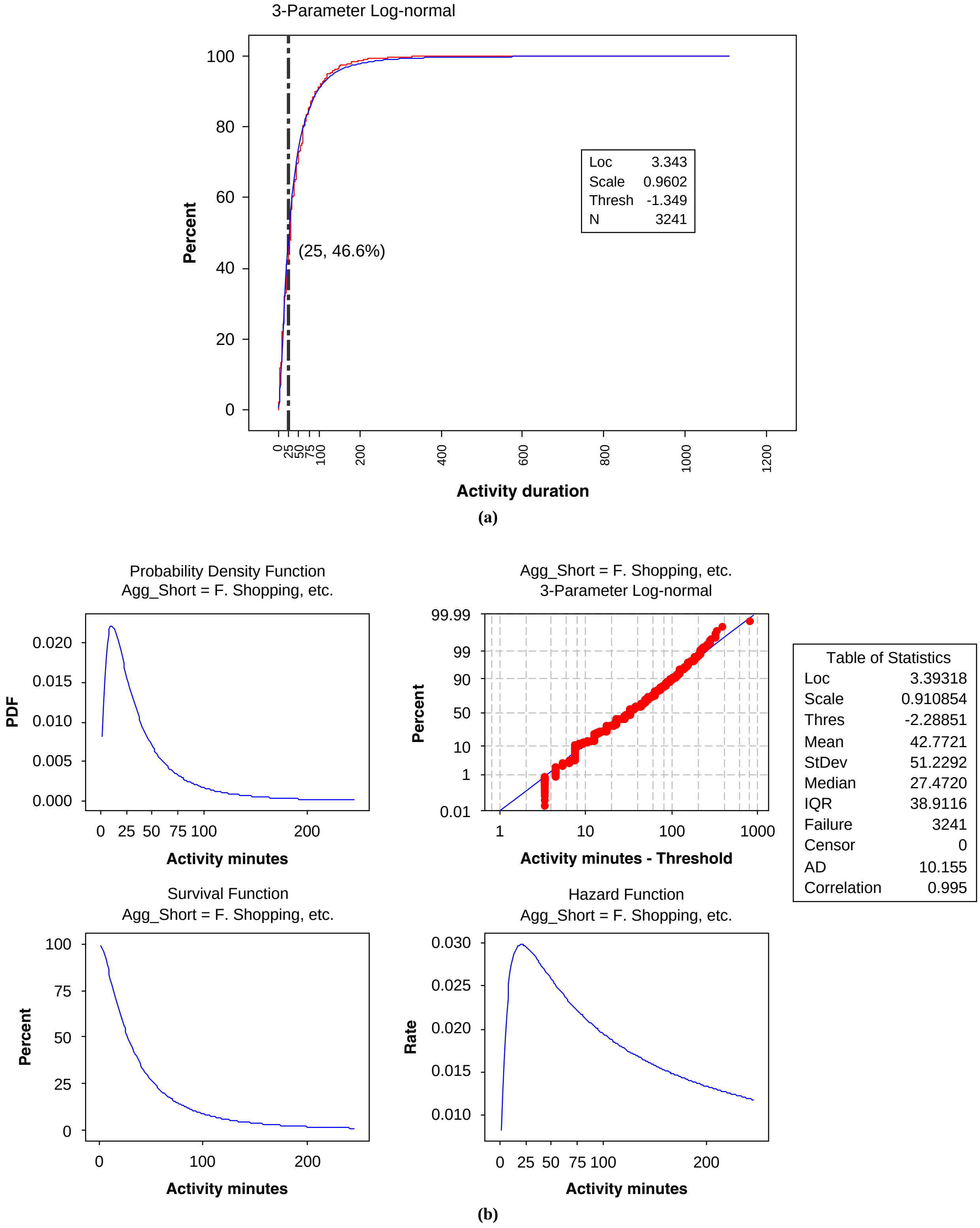


FIGURE 4 (*a*) Empirical cumulative distribution function and (*b*) distribution overview plot for weekend shopping activities (AD = adjusted Anderson–Darling test statistics).

developed models could be more accurate if real durations would have been reported. Such a problem may be solved by "imputing" these rounded observations back into a normally distributed population. Future research will explore this issue.

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