
Original Paper

BASIC CHARACTERISTICS OF RECREATIONAL TRIP CHAINING BEHAVIOR : ACTIVITY-BASED ANALYSIS

(Received on 31, August 1993)

by Hideki FURUYA*, Kazuo NISHII* and Tsutomu SAKAI*

Abstract

The purpose of this paper is to analyze recreational trip chaining behaviors under time-space constraints. The recreational trips included in these chains are characterized as a concentration into the specific time of a day and the affected district of the studied area. This analysis becomes important because recreational trips are often the cause of serious traffic congestion on highways and arterial roads on holidays.

In this paper, an activity-based approach is applied to explain recreational trip chaining. The concept of the time-space prism is first introduced for the purpose of describing those travel and activity linkages under temporal and spatial constraints. Secondly, the differences in recreational behaviors by access-distance are focused on in relation to the temporal utility profile.

The study shows that temporal constraints underly recreational trip chaining behavior. This paper presents that, under this constraint, tourists arrange the utilities obtained from recreational activities with the disutility related to the travel time. This paper also discusses how the access-distance will determine the formation of recreational trip chaining behavior when taking typology of the utility profiles into consideration.

1. INTRODUCTION

Recreational trips are characterized by peaks of the specific hours of a day and by affected points in those temporal and spatial distributions. On an arterial-road in a recreational area, traffic congestion occurs in the morning and evening hours on holidays. Local traffic jam also occurs near parking lots and intersections approaching to the sightseeing spot.

This paper intends to analyze an individual's activity and travel linkage to identify basic characteristics underlying recreational trip chaining behavior. Of particular concerns are the timing and temporal constraints; the arrival and departure time, and the duration in a recreational area. This analysis also focuses on the distance accessing to the area from home, denoted as an access-distance. It is considered to be one of the factors determining the formation of recreational trip chaining.

This study presents some empirical observations from an analysis of the recreational trip chain

* Department of Civil and Environmental Engineering, Yamanashi Univ.

data obtained in the Fuji-five lakes area. The analysis is based on two key concepts in an activity-based approach; a time-space prism and a utility profile.

This paper is composed of the following five sections: The second section introduces the basic concepts of both time-space prism and utility profile through a review of the recent advances in activity-based approach. The third section provides a description of the case-study area with regard to traffic flow patterns in the arterial roads. In the fourth section, recreational trip chaining behaviors in the studied area are empirically analyzed. The tradeoff between the duration and the arrival time at the area is discussed with the temporal constraints underlying the decision structure of those behaviors. Some types of utility profiles over time are also explained in light of the access-distance from home to the area as well as the temporal constraints. Finally the conclusions of this study are presented in the fifth section.

2. ANALYTICAL FRAMEWORK IN THIS STUDY

One of the focuses in this paper is temporal and spatial constraints determining recreational trip chaining behaviors. While the activity-based approach aims at a time-space representation of human activity patterns, Hagerstrand (1970) and Hemmens (1970) developed a time-geography model of travel and activity linkages and provided the fundamental paradigm underlying the decision structure of trip chaining behavior. This paradigm is called time-space prism, which describes the area available for activity and travel in the temporal and spatial coordinates. Burns (1979) developed the accessibility methodology using the concept of this time-space prism. Under this paradigm, it is assumed that every activity sequence in a single day is part of an individual's time-space path which is influenced by his/her time-space prism dimensions. Although empirical results have rarely been reported in previous trip chaining research, a few studies have recently tried to theoretically identify fundamental properties of trip chaining behavior (Kitamura & Kermanshah (1978), Kitamura (1985)). Nishii, Kondo & Kitamura (1988) and Nishii &

Kondo (1992) have empirically examined trip linkages under time-space constraints. These studies suggest that it is important to incorporate temporal and spatial constraints into the analytical framework of the activity-based approach.

In the case of recreational travel behaviors, there are few studies in which activity-based analysis has been applied to understanding their characteristics about the formation of trip chaining under time-space constraints. A recreational activity is clearly linked with the movement between home and the sightseeing spot so that temporal and spatial constraints can be satisfied in the whole day. If an individual makes a one day trip from his home to a recreational area by car with his family, he will probably recognize the possibility of a tradeoff between the arrival time and the duration in the area beforehand. He may also try to arrange their travel schedule considering the access-distance and the returning time to home. This means that the concept of time-space prism is useful for explaining the characteristics of recreational trip chaining behaviors.

Consider an abstract linear model in which opportunities for recreational activities are uniformly distributed. Then let us suppose that an individual visits a recreational area using the highway. Assuming that the individual uses the shortest path for a given speed of travel, the region accessible to the individual in time-space coordinates in the recreational area can be defined as time-space constraints shown in **Figure 1**.

In this figure, an individual starts from home at

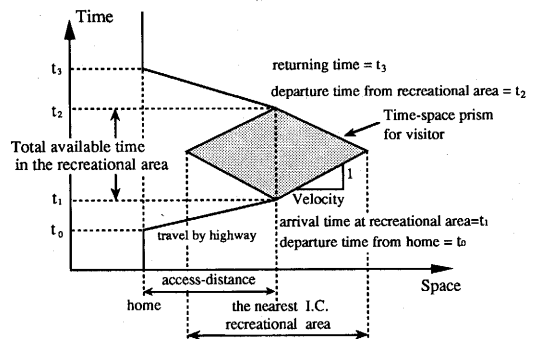


Figure 1 Time-space prism involving recreational travel behavior in a linear model

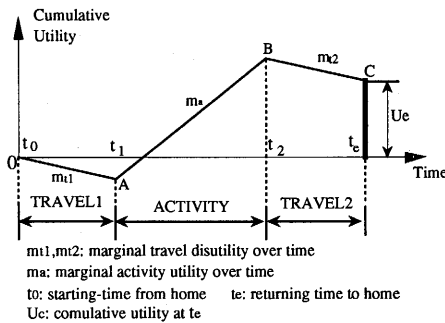


Figure 2 Utility profile for the out-of-home activity and travel

t_0 , arrives at the area at t_1 and stays until t_2 . The duration from t_1 to t_2 corresponds to the total available time for recreational activities and travel. After spending time in the area, the individual re-enters the interchange at t_2 and returns home at t_e . While the total available time is determined by the activity duration as well as the arrival and departure time, it is here assumed that the choice of the arrival time at the area is made considering the time required for the recreational activity. It is therefore hypothesized that there exists a tradeoff between the arrival time and the duration satisfying the prism constraint.

On the other hand, Supernak (1988, 1992) developed the concept of a temporal utility profile. **Figure 2** shows a typical example of temporal utility profile for the out-of-home activity and travel. In this figure, cumulative utility is expressed in the vertical axis, the value of which is dependent upon the utility and disutility derived from travel and activity linkage over time. This concept is regarded as a useful tool for evaluating the utility accumulation throughout the whole day as well as formulating a dynamic decision mechanism underlying trip chaining behavior. It is noted that a marginal utility from activity over time and a marginal disutility from travel are here assumed to be constant, although this assumption can be relaxed to allow us to use non-linear diminishing function of the duration. It is also clear that a marginal utility has a variety of the values depending on the nature of the activity-type. In addition, it is impor-

tant that the effect of an access-distance on the formation of trip chaining is taken into consideration.

In the empirical observations of recreational trip chaining behavior in the following section, these key concepts are used as an analytical framework of this study.

3. SUMMARY OF THE STUDIED AREA

The Fuji-five lakes area under study covers a range of about 25 km from the East to the West. While this area is famous for the natural beauty of its lakes and for Mt. Fuji in Japan, the location is such that it takes one hour and a half to drive by car from Tokyo on the Chuo highway. Even so, more than 15 million tourists visit there annually. Twelve million of them are one day visitors from Tokyo metropolitan area. As most visitors travel there by private car, serious traffic congestion has often occurred on the arterial roads in recent years.

The number of visitors to this area, has shown a tendency to rise and fall according to the condition of the Chuo highway; the accessibility of this highway has been changing as the network equipment has improved. When a branch line of Chuo highway was completed through Choufu I.C. to Kawaguchiko I. C. in 1968, the number of visitors rose to about 10 million, an increase of 2 million. In 1984, all line of the Chuo highway were completed and this change had almost the same impact as the number of visitors reached about 12 million. This indicates that improvements in the accessibility of the roads bound for Fuji-five lakes area leads not only to an increased number of recreational trips but also a change the time-use patterns in the recreational one-day excursion.

The traffic volume on an arterial line in a recreational area varies widely in its distribution over time; a year, a week and a day. For example, the route 139, that is, one of two-lanes arterial road through Fuji-five lakes, accepts 6,803 vehicles on the annual average daily trip (A.A.D.T.), while the average traffic volume on holidays is 10,230 vehicles. It is 1.5 times larger than the A.A.D.T. This means that the traffic volume has a highly peaked distribution on holidays and also that it has a con-

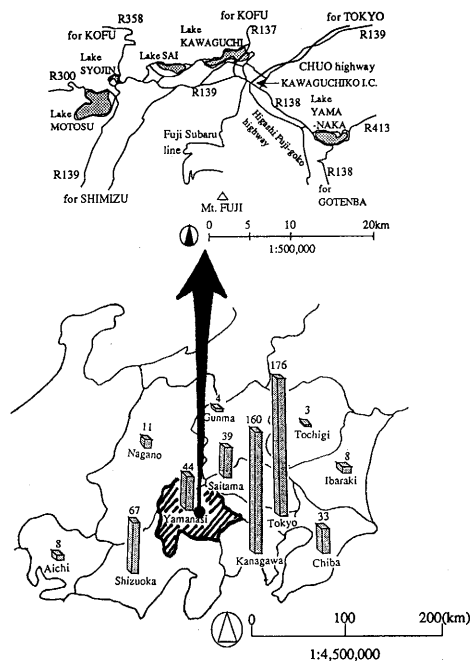


Figure 3 The studied area and the distribution of recreational trip generations by visitors

centration even in the hourly traffic flow patterns. Detailed discussion is referred to the previous efforts by Furuya et. al. (1991).

In this analysis, the data set from Recreational Trip Behavior Survey is used. This survey was conducted in the autumn of 1991. The data set contains the records of personal recreational activity; the time-table of the surveyed day, the arrival and departure time, and the spatial distribution of visiting stops. Of the 989 individuals sampled in this survey who visit this area and to park their cars near the lakes are, 563 individuals are classified as one-day visitors. This survey contains individual's attributes, types of sightseeing activities and the stated preference data concerning an evaluation of the road improvement policies and projects (Nishii et. al. (1993)).

Figure 3 shows a map with principle road-networks under study and the distribution of recreational trip generations. This figure indicates that the percentage of individuals coming from Tokyo account for 75% of all visitors to this area.

Figure 4 presents the relative frequency of the access-distance for those who visit Fuji-five lakes area. It can be found from this figure that the individuals who visit there with an access-distance less than 100 km account for 70% of all visitors to this area. While the access distance to Fuji-five lakes area is not very great for one-day visitors, this may be partly attributed to the fact that both Tomei and Chuo highways pass close to Lake

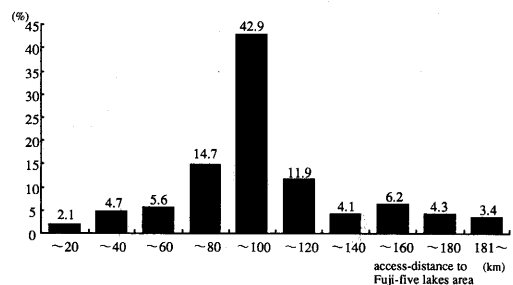


Figure 4 The relative frequency of the access-distance for visitors

Yamanaka and Lake Kawaguchi and that most of these visitors come from the Tokyo metropolitan area.

4. EMPIRICAL OBSERVATIONS OF RECREATIONAL TRAVEL BEHAVIOR

As mentioned in the previous section, temporal constraints generally play an important role in the formation of trip chaining behavior. In this study, the total available time determines the time-space path within the prism as well as the duration for activity.

Figure 5 shows the distributions of the arrival and departure time for recreational trips. This figure indicates that the distribution of the arrival time at the area has a distinct peak in the morning hour. It can be found that almost half of all visitors arrive at the area before 10 o'clock and that the 90% of them do so before 14 o'clock. This figure also indicates that the distribution of the departure time from the area has a peak in the hours between 14 and 17 o'clock. While the 50% of visitors depart from this area until 15 o'clock, they may include those tourists who arrived early and those who arrived late. It is noted that the distribution of the departure time has a larger variance than that of the arrival times.

Let us examine the relationship between the arrival time and the duration of recreational activity at the area. Figure 6 shows the tradeoff between them and the regression function. It is evident from this figure that the duration for recreational activity is strongly determined by the arrival time. As shown in this figure, the estimated regression function has a high correlation coefficient 0.972. This function also indicates that an individual who arrives at the area one hour late will shorten the duration by 36 minutes and delay the departure for about 24 minutes.

It is noted, however, that the values of the standard deviation in the duration for early visitors tend to be larger than those for late ones. This implies that early visitors can have the degree of freedom for spending time for recreational activity and that late visitors, on the other hand, tighten their temporal constraint. It is clear that such a

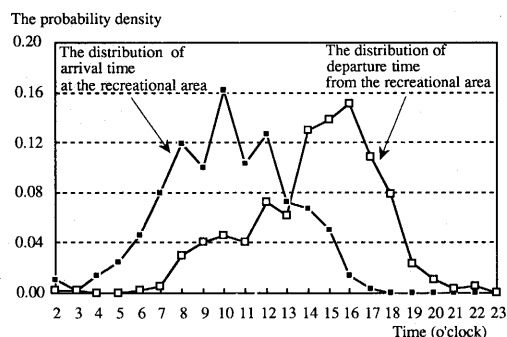


Figure 5 The distributions of arrival time and departure time in recreational trips

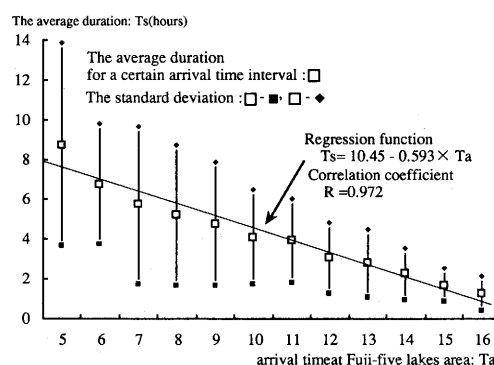


Figure 6 The relationship between arrival time and average duration in the recreational trip chaining

difference can be explained by using the area of the time-space prism.

While the arrival time obviously influences the duration for activity as mentioned before, it also has a close relationship with the access distance. Figure 7 indicates relative frequencies of the arrival time by access distance. This figure shows a difference in the distribution by access distance. This figure shows a difference in the distribution by access distance—the longer the distance approaching to Fuji-five lakes area is, the sharper the peak of distribution of the arrival time becomes. If it were assumed that as the access distance becomes longer, the arrival time shifts to the corresponding late

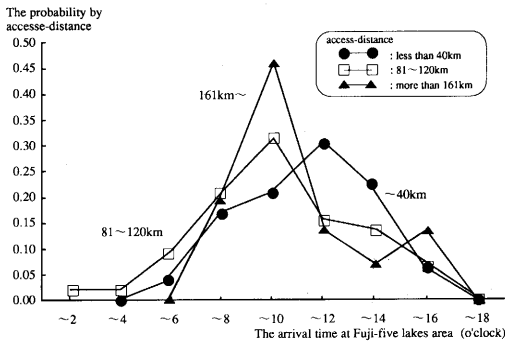


Figure 7 The distributions of arrival time by access-distance

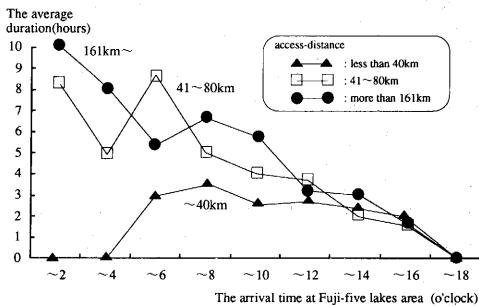


Figure 8 The distributions of the average duration by access-distance

time, the distributions by access-distance would be hardly distinguished from each other, although we can find only difference in the average values of the arrival time for each access-distance level. The figure suggests that this assumption is not correct and that the shapes of the distributions by the access-distance are different from each other. In the case that the access-distance is less than 40 km, the relative frequency of the arrival time is distributed round 14 o'clock with a relatively large variance. It is noted that the peak arrival time occurs in the afternoon. This tendency implies the existence of the relationship between the arrival time and the duration for recreational activity under the temporal constraint.

Next, let us empirically examine such a relationship in travel and activity linkage. Figure 8 shows the distributions of the average duration by arrival time and by access-distance. The access-distance is here categorized into three groups; less

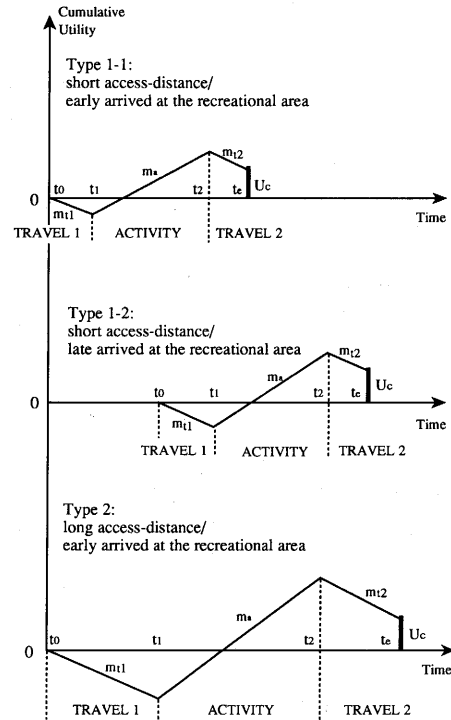


Figure 9 Utility profiles for out-of-home activity and travel by access-distance and arrival time

than 40 km, between 40 km and 80 km, and more than 160 km. They correspond to short, middle, and long access-distance, respectively. This figure indicates that the middle and long access-distance groups have a negative correlation between the duration and arrival time. This means that, the earlier the individuals arrive at the area, the longer duration they can have for recreation activity. On the other hand, in the case of the short access-distance group, the average duration by arrival time has no difference from each other.

The concept of utility profile is here introduced to represent a recreational activity and travel linkage considering the characteristics obtained from the empirical analysis of recreational trip chaining behaviors. Figure 9 shows three types of the temporal utility profiles for recreational trip chaining by access-distance.

According to the result shown in Figure 7, visitors who belong to the short access-distance

group can be classified into two types. The first type is those who arrive at the area in the morning and depart after spending a few hours for recreational activity. The other is those who arrive there before the noon or early in the afternoon and depart late in the afternoon. It is noted that these types have almost the same average duration for activity although the arrival time at the area is different from each other.

Visitors having an access distance between 40 km and 80 km belong to the middle access-distance group. They arrive at the area early in the morning and depart there after spending relatively many hours in the evening. It is noted the distribution of the departure time for this group has a heavy concentration in the evening. Their temporal constraints are furthermore tightened because of the traffic jam in the evening hours on holidays. They tend to spend much time for activity at the recreational area to gain utility and to compensate for the disutility from long access-distance.

5. CONCLUSIONS

This paper analyzes recreational trip chaining behaviors using an activity-based approach. The concept of time-space prism is introduced for the purpose of describing those travel and activity linkages under temporal and spatial constraints. Second, typical utility profiles of recreational trip chaining behavior are presented considering both the role of the access-distance and the relationships between the arrival time and the duration.

The result indicate that the duration for recreational activity is strongly determined by the arrival time and that the values of the standard deviation in the duration for early visitors tend to be larger than those for late visitors. This implies that early visitors have a degree of freedom for spending time for recreational activity and that late visitors, on the other hand, tighten their temporal constraint. In this study, such a difference can be explained by using the area of the time-space prism.

This study also empirically examines the distributions of the average duration by arrival time and by access-distance. The result suggests that the middle and long access-distance groups have a

negative correlation between the duration and arrival time and that the earlier the individuals arrive at the area, the longer duration they can have the duration for recreation activity. On the other hand, in the case of the short access-distance group, the average duration by arrival time shows no difference.

REFERENCES

- HAGERSTRAND T.: What about people in regional sciences? *Papers of Regional Science Association* **25**, 7-21, 1970
- HEMMENS G. C.: Analysis and simulation of urban activity patterns, *Socio-Econometric Planning Science* **4**, 53-66, 1970
- BURNS L. D.: Transportation, Temporal, and Spatial Components of Accessibility, Lexington Books, MA, 1979
- KITAMURA R. & M. KERMANS SHAH: Sequential model of interdependent activity and destination choice, *Transportation Research Record* **987**, 81-89, 1978
- KITAMURA R.: Trip chaining in a linear city. *Transportation Research* **19A**, 2, 155-167
- NISHII K., K. KONDO & R. KITAMURA: Empirical analysis of trip chaining behavior, *Transportation Research Record* **1203**, 243-257, 1989
- NISHII K. & K. KONDO: Trip linkages of urban commuters under time-space constraint: some empirical observations, *Transportation Research*, **26B**, 1, 33-44, 1992
- SUPERNAK J.: A dynamic interplay of activities and travel: Analysis of day utility profiles. *New Developments in Dynamic and Activity-Based Approaches*, edited by P. B. Jones, Oxford, England, 1988
- SUPERNAK J.: Temporal utility profiles of activities and travel: uncertainty and decision making, *Transportation Research*, **26B**, 1, 61-76, 1992
- FURUYA H., K. NISHII, T. SATOH & T. HANAOKA: Traffic flow analysis of recreational arterial for their improvements, *Proceedings of Infrastructure Planning, Journal of The Japan Society of Civil Engineers*, **9**, (in Japanese), 109-116, 1991
- NISHII K., T. HANAOKA, H. FURUYA & T.

SAKAI : On the concept of level of service related
to the driver's evaluation for recreational arterial,

Papers on City Planning, 28, (in printing, in
Japanese), 1993
