STUDY ON THE STRUCTURAL MECHANISM OF TRAFFIC DEMAND BASED ON THE CONNECTING STRUCTURE OF TRIP PURPOSE

Tomonori KOUHARA
Master course
Dept. of Civil Engineering
Kyushu University
FUKUOKA, Higashi-Ku
812-8581 Japan
Fax:+81-92-642-3278
E-mail:kou@civil.doc.kyushu-u.ac.jp

Takeshi CHISHAKI
Professor
Dept. of Civil Engineering
Kyushu University
FUKUOKA, Higashi-Ku
812-8581 Japan
Fax:+81-92-642-3276
E-mail:chishaki@civil.doc.kyushu-u.ac.jp

Yoshitaka KAJITA
Research Associate
Dept. of Civil Engineering
Kyushu University
FUKUOKA, Higashi-Ku
812-8581 Japan
Fax:+81-92-642-3278
E-mail:kajita@civil.doc.kyushu-u.ac.jp

Abstract: Sequential trips of individuals are related each other in some meanings, and its relation may be statistically represented by the connecting structure of trip purposes. Therefore, the mechanism of traffic demand will be fundamentally understood under the consideration of sequential travel activities of individuals. A new approach for the prediction of traffic demand is studied in this paper, reflecting major differences of travel activities in individual attributes, and analyzing the sequential mechanism of trip purposes in traffic demand. Similarity and dissimilarity of traffic activities by personal attributes is analyzed in each steps of trip demand. Then, in each group of individuals, the relationships among purposes of the generated trip and its preceding trip is investigated by the use of cross table. And, based on connecting mechanism in purposes of sequential trips, trip generation & attraction models are also built up.

1. INTRODUCTION

Traffic demand in urban area come from economy and living activities, and is closely related with society activities, too. Therefore, it is necessary to analyze traffic activities and to forecast traffic demand, considering the paradigm shift of society in future such as increase of aging and female working population, internationalization and change of industrial structure.

On the other hand, four steps model (trip production, trip generation & attraction, trip distribution and modal choice) is usually used to understand traffic activities in the making of master plan for traffic and so on. However, as four steps model is separately constructed in every step, it is not enough to grasp the essential relation among four models to reflect the paradigm shift of society. Consequently, it is difficult to essentially and exactly forecast traffic demand in future under the university and the applicability. In order to resolve these issues mentioned above, it is important to forecast traffic demand, introducing of the concept of trip connecting mechanism in each group of person attributes. Moreover, it is necessary to keep the simplicity of forecasting model for the application in practice.

In this study, sequential relationship between former and latter trips in each group by person attributes is analyzed. Moreover, based on these results, forecasting model of traffic

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

demand is constructed and forecasting system of traffic demand is studied using the data of the second person trip investigation (1983) in Northern Kyushu Area. It can be said that the paradigm shift of society mentioned above is finally regarded as the structural change of personal attributes such as sex, age and job. Thus, as for groups by sex, age and job, groups of similar traffic activities are united from comprehensive viewpoint. Next, sequential connecting structure of traffic activities is analyzed in each united group of personal attributes. That is, trip generated by a purpose is related with any trip attracted at the preceding step or trip production. Also, connecting mechanism of trip production, trip generation & attraction in traffic demand for each group of personal attribute is analyzed. Base on the structure of traffic demand, trip generation & attraction models are also built up.

2. CLASSIFICATION OF TRIP PURPOSES

Trip purposes at questionnaire surrey are fundamentally divided into 18. While the trip purposes are categorized in similarity of traffic characteristics, they are united to 8 subdivisions, or 5 divisions as in Table-1. Traffic demand is generally analyzed and forecasted, using 8 subdivisions of trip purposes. However, it is difficult to analyze the connection of former and latter trip of individual using this classification, and it is important to classify trip purpose analyzing on the similarity of characteristics of trip through all of four steps. Therefore, new classification of trip purpose is proposed to analysis exactly sequential connection of trips of individual referred to our preceding study[1]. New classification of 15 purposes is shown as in Table-2. Business trip, private trip and other private trip (back) are especially subdivided. Business1 trip is classified into 4 groups; purposes concerning only personal activities, the one related to goods, trips related with both of person and good, and others. Going home trip is also classified into 4 groups based on the type purpose of the back trip from the preceding trip.

Table-1   Classification of trip purposes (the second person trip survey in Northern Kyushu Area)

Purpose code	18 purposes related to both of persons and goods	Subdivision	Division
1	Go for work	Commuting trip	Commuting trip
2	Attend to school	Attending trip to school	Attending trip to school
3	Goods delivery	Business1	Business
4	Bring document for business		
5	Meeting		
6	Go for repairing		
7	Investigation		
8	Back to office		
9	Other business purposes		
10	Go for agriculture	Business2	
11	Back from agriculture		
12	Go shopping	Private1	Private
13	Recreation		
14	Back to school	Private2	
15	Other private trip (go)		
16	Back from work	Going home1	Going home
17	Back from school		
18	Other private trip (back)	Going home2	

Table-2 Classification of trip purposes for the study

Purpose code	Converted trip purposes	Specification
1	Go for work	Go for work
2	Attend to school	Attend to school
3	Business trip 1	Goods delivery and bring document for business
4	Business trip 2	Go for meeting, investigation and trip for other business purposes
5	Business trip 3	Go for repairing
6	Business trip 4	Back to office
7	Business trip 5	Go for agriculture
8	Private trip 1	Go shopping and recreation
9	Private trip 2	Back to school and other private trip (go)
10	Back from work	Back from work
11	Back from school	Back from school
12	Other private trip (back)	Back from other private trip
13	Business 5 (back)	Back from agriculture
14	Private 1 (back)	Back from private 1
15	Private 2 (back)	Back from private 2

3. CATEGORIZATION OF PERSONAL ATTRIBUTES UNDER THE CHARACTERISTICS OF TRIPS

3.1 Trip production by age and job

Before unifying or categorizing individuals by age and job, we need to check the number of trip production in each group which is shown as in Table-3. There are a lot of groups, which number of trip production is almost zero, by sex, age and job. For example, persons under 14 years have no business travel. Also, precision of small traffic demand is not good and negligible. Thus, to get the sufficient number of trip production, numbers of trip production are calculated in each group by the cross table of age and job. Groups which number of trip production is under 200 are eliminated from analysis considering average expansion coefficient, 20. If sum of small sized samples for two adjoining groups by age is about 1000, they are also united as one group.

Table-3 Original categories of personal attributes

Sex	2 groups	Male, Female
Age	20 groups	Divided 5 years
Job	12 groups	Clerical and related workers, Managers and officials, Sales worker, Agricultural workers, Workers in transport occupation, Production process workers, Mining workers, Service workers, Student, Child, Wife and Unemployed
Zone		27 zones in Fukuoka city area (wards, cities, towns and villages district

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

3.2 Setting of personal attributes groups

Traffic activities have evidential difference among personal attributes (sex, age and job). And, forecasting models in each stage of travel are influenced by personal attributes. Therefore, as for person attributes, similarity of individuals in travel activities must be clssified and grouped from a comprehensive viewpoint of traffic activities. Here, similarity of individuals by personal attributes is studied based on five distributions; trip production, trip purpose, relationship of origin and destination, modal choice and sequential connecting structure of trip purposes. That is, in Northern Kyushu area, five distributions above are calculated in all groups given in the preceding section. In each sex group, correlation between groups by cross of age and job is analyzed, and similarity of groups at distributions of travel characteristics is classified by the use of cluster analysis.

Table-4　Classification of age groups by various distributions of trip characteristics in Clerical and related workers (male)

Clerical and related workers age	Trip purpose distribution	Trip production distribution	OD distribution	Modal choice distribution	Trip connect-ing structure	Group at compre-hensive viewpoint	A rate of number of trips
0 to 4							0.000
5 to 9							0.000
10 to 14							0.000
15 to 19	1	1	1	1	1	1	0.011
20 to 24	1	1	1	1	1	1	0.097
25 to 29	2	1	1	1	1	1	0.154
30 to 34	2	1	1	1	1	1	0.190
35 to 39	2	1	1	1	1	1	0.152
40 to 44	2	1	1	1	1	1	0.121
45 to 49	1	1	1	1	1	1	0.091
50 to 54	1	1	1	1	1	1	0.081
55 to 59	1	1	1	1	1	1	0.057
60 to 64	3	1	1	2	1	2	0.024
65 to 69	3	1	1	2	1	2	0.012
70 to 74	3	1	1	2	1	2	0.005
75 to 79	3	1	1	2	1	2	0.002
80 to 84	4	2	2	3	2	2	0.0003
85 to 89	4	2	2	3	2	2	0.0003
90 to 94							0.000
95 to 99							0.000

Table-5　Classification of age groups by various distributions of trip characteristics in service workers (female)

Service workers age	Trip purpose distribution	Trip production distribution	OD distribution	Modal choice distribution	Trip connect-ing structure	Group at compre-hensive viewpoint	A rate of number of trips
0 to 4							0.000
5 to 9							0.000
10 to 14							0.000
15 to 19	1	1	1	1	1	1	0.025
20 to 24	1	1	1	2	1	1	0.084
25 to 29	1	2	1	2	2	1	0.077
30 to 34	2	3	1	2	2	2	0.124
35 to 39	2	3	1	2	3	2	0.143
40 to 44	2	4	1	3	3	3	0.139
45 to 49	2	4	1	3	3	3	0.130
50 to 54	2	4	1	3	3	3	0.111
55 to 59	2	4	1	3	3	3	0.078
60 to 64	2	4	2	4	3	3	0.045
65 to 69	2	2	2	4	4	4	0.024
70 to 74	2	2	2	4	4	4	0.012
75 to 79	2	2	2	4	4	4	0.002
80 to 84							0.001
85 to 89							0.000
90 to 94							0.000
95 to 99							0.000

Moreover, not only statistics analysis but also meaning of group should be taken into consideration. Many groups are secured enough samples of trip production. However, 1000 trips of production are not enough for analysis and forecasting of traffic demand by 15 trip purposes. To resolve this problem, in especially aged population groups, if peoples have same occupation, it is guessed that traffic activities of them are almost same. Adjoining groups are united to secure enough samples of trip production.

Table-6 Classification of age groups in each job (male)

age	Clerical and related workers	Managers and officials	Sales worker	Agricultural workers	Workers in transport occupation	Production process workers	Mining workers	Service workers	Student	Child	Wife	Unemployed
0 to 4 age										1		
5 to 9										2		
10 to 14								1	1	3		1
15 to 19	1		1	1	1	1		1	2			1
20 to 24	1	1	1	1	1	1	1	2	2			1
25 to 29	1	1	2	1	1	1	2	2	3			2
30 to 34	1	2	2	2	1	1	2	2	3			2
35 to 39	1	2	2	2	1	1	2	2	3			2
40 to 44	1	2	3	2	1	1	2	2	3			3
45 to 49	1	2	3	2	1	1	3	2	3			3
50 to 54	1	2	3	2	2	1	3	2	3			3
55 to 59	1	2	3	2	2	1	3	2				3
60 to 64	2	2	3	2	2	2	3	2				4
65 to 69	2	3	4	3	2	2	3	2				4
70 to 74	2	3	4	3		3		3				4
75 to 79	2	3	4	3		3		3				4
80 to 84	2	3	4	3		3						4
85 to 89	2	3	4	3		3						4
90 to 94												4
95 to 99												

Note: Blank is no trips or small size of samples;
Number is Group No. classified in each job.

Table-7 Classification of age groups in each job (female)

age	Clerical and related workers	Managers and officials	Sales worker	Agricultural workers	Workers in transport occupation	Production process workers	Mining workers	Service workers	Student	Child	Wife	Unemployed
0 to 4										1		
5 to 9										2		
10 to 14						1		1	1	3	1	1
15 to 19	1	1	1			1		1	2		2	1
20 to 24	1	1	1	1	1	1		1	2		2	1
25 to 29	2	1	2	2	1	2		2	3		3	1
30 to 34	2	2	2	2	1	2		2	3		3	1
35 to 39	2	2	2	3	2	2		3	3		4	1
40 to 44	2	3	2	3	2	3		3	3		4	2
45 to 49	2	3	2	3	2	3		3	3		4	2
50 to 54	3	3	2	3	2	4		3	3		4	2
55 to 59	3	3	2	3		4		3			4	2
60 to 64	4	4	2	3		4		4			4	2
65 to 69	4	4	2	3		4		4			4	3
70 to 74	4	4	3	3		4		4			4	3
75 to 79	4	4	3	3		4		4			4	3
80 to 84				3							4	3
85 to 89				3								3
90 to 94												3
95 to 99												

Note: Blank is no trips or small size of samples;
Number is Group No. classified in each job.

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

To the limitation of space of this paper, some representative results are shown as in **Table-**4 and 5. Moreover, from the results of categorization by all distributions and meaning of group, groups by cross table of age and job are classified from the comprehensive viewpoint in each sex, as shown in Tables-6 and 7. In male, 33 categories are obtained, while 37 categories in female.

4. ANALYSIS OF TRIP CONNECTING STRUCTURE OF TRIPS IN EVERY GROUP BY PERSONAL ATTRIBUTES

In traffic activities, a person takes traveling action for a purpose such as commuting, attending to school, business, private and so on. And, one trip is an traveling action that trip originates at a zone and destinies to other zone. Almost persons have two trips or over in a day. Therefore, traveling activities by individuals have various characteristics and complicated, and it is difficult to grasp them individually. However, persons depart from a zone to its destination place, and almost of them finally comes back to the originating zone in a day. So, it is seemed that the pattern of traffic activities by persons have some similarity in its characters and are categorized. Thus, it is easily guessed that traffic activity for a purpose will be related with the purpose of the preceding trip.

Connecting structure of trips by individual is different in accordance with numbers of trip production and its turn. However, from a wide viewpoint, it is possible to understand the connecting structure of trip purposes and to analyze relationships between purposes of former and latter trips and sequential characteristics of travel such as production, generation and attraction. That is, in this study, only relationship of purposes between former and latter trips, not considering the concept of cycle in trip chain, is studied for the understanding of trip connecting structure. Then, trip connecting structure are summarized as a table. A row in the purpose of table is the preceding attracted trip, and column is the purpose of generated trip which sequentially connects with the preceding trip. That is, it is assumed that the volume of trip attraction by preceding trip is equal to the one of trip generation for a subjective trip purpose. The first trip in a day is seemed to be trip production. Therefore, purposes of the preceding trip have 16 categories including trip production.

4.1 Table of connecting structure of trips

Before discussing the connecting structure in purposes of sequential trips in each group, trip connecting cross table for all of groups is built up to understand a general tendency. The result is shown as in Table-8. From this table, ratios of preceding trip attraction with each purpose in following trip generation for a purpose are calculated. For example, the ratios of commuting trip, business 1 trip, private 1 trip and back trip from school are obtained as shown in Figure-1, 2, 3 and 4. Purpose of preceding trips in trip generation for commuting trip and attending trip to school is almost trip production. That is, in trip chains, trip generation for these purposes is the first in a day. Also, 40 % of generated trips for private has trip production as the preceding trip. But, its tendency is different between personal attributes.

$$(zone \quad i) \xrightarrow{\quad preceding \quad trip \quad} [zone \quad j] \xrightarrow{\quad subjective \quad trip \quad} (zone \quad k)$$

In purpose of the preceding trip of trip generated for business trip, the rate of commuting is high. Also, for the reason that business is frequently in a day, the rate of preceding business trips is high. As business 4 trips includes back trips to office, the sum of samples, which have business1, 2, and 3 trips as the preceding trips, reaches 90% of all.

Table-8 Connecting structure in purposes be⁺ween sequential trips of preceding attracted trip and following generated trip (all groups)

| Purpose of subjective trip \ Purpose of preceding trip	Comm-uting	Attend-ing	Busine-ss1	Busine-ss2	Bsine-ss3	Busine-ss4	Busine-ss5	Privat-e1	Privat-e2	Home from comm-uting	Home from attendi-ng	Home (other)	Home from busine-ss5	Home from privat-e1	Home from privat-e2	Total
Trip production	1389617	1019711	83632	71129	65817	872	68335	563584	460712	10921	0	13823	0	0	0	3748153
Commuti-ng	0	0	126595	94908	50708	171	466	121093	45861	1020015	0	0	0	0	0	1459817
Attending	0	0	0	0	0	0	0	32321	30850	0	967154	0	0	0	0	1030325
Business1	9075	0	211151	23721	6445	245077	885	15219	9133	0	0	39018	0	0	0	559724
Business2	6556	0	19291	78967	8259	142552	344	18456	10839	0	0	56522	0	0	0	341786
Business3	1651	0	5947	10330	28119	99149	169	4553	3028	0	0	29948	0	0	0	182894
Business4	0	0	86709	39881	17989	65	3125	35432	18837	210268	0	0	0	0	0	412306
Business5	56	0	939	588	146	2242	4016	2344	1539	0	0	6749	99582	0	0	118201
Private1	10142	1739	8549	8897	2524	38177	1480	115473	74261	0	0	0	0	1052767	0	1314009
Private2	14809	4489	6204	6356	1276	15993	684	133355	122878	0	11685	0	0	0	692234	1009963
Home from commuti-ng	6793	0	2496	4658	287	18988	1006	39441	23541	0	0	0	0	0	0	97210
Home from attending	0	2007	0	0	0	0	0	77598	96746	0	0	0	0	0	0	176351
Home (other)	4985	309	2698	2494	838	2484	1665	6632	5326	0	0	0	0	0	0	27431
Home from business5	0	0	1559	1264	279	0	31180	4475	3134	90	0	0	0	0	0	41981
Home from private1	8542	1055	3245	2473	736	1424	2583	85817	61858	0	0	0	0	0	0	167733
Home from private2	6012	2354	3786	2463	844	1315	2835	69311	74688	0	0	0	0	0	0	163608
Total	1458238	1031664	562801	348129	184267	568509	118773	1325104	1043231	1241294	978839	146060	99582	1052767	692234	10851492
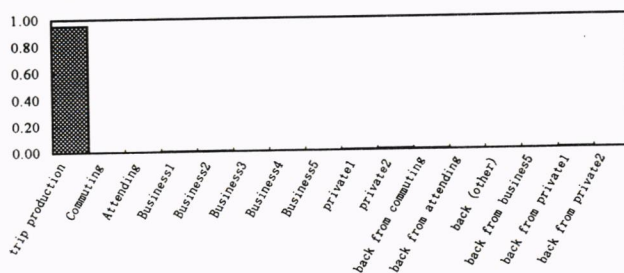
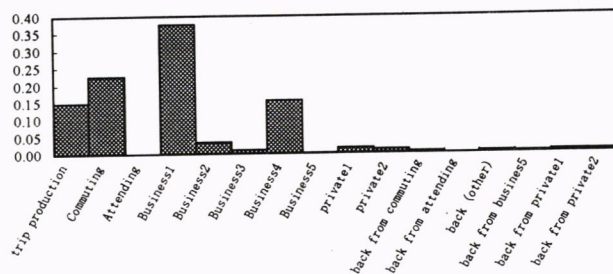**Figure-1 Trip distribution by purpose of preceding trip in commuting**

Figure-2 Trip distribution by purpose of preceding trip in business1

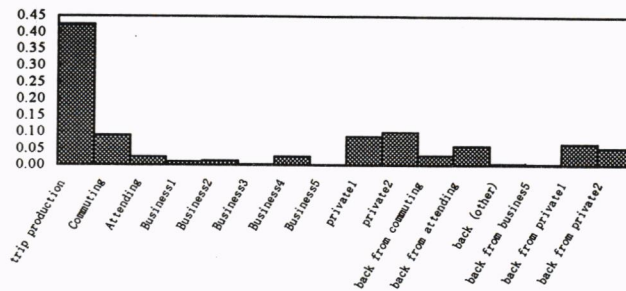Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

Figure-3   Trip distribution by purpose of preceding trip in private1
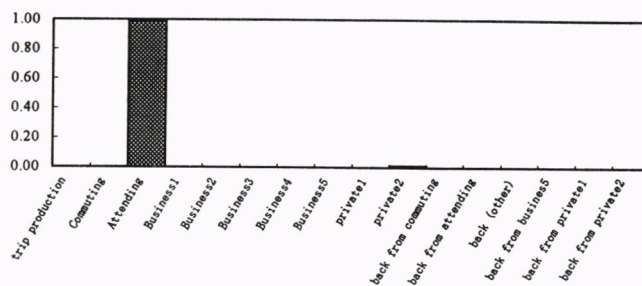

Figure-4 Trip distribution by purpose of preceding trip in home from attending

4.2 Sequential structure of trips in each personal attribute

In detail, connecting structure between sequential trips are different among groups in attribute of persons. That is, traffic activities are different among personal attributes (sex, age and job). By group adjusted in preceding chapter, characteristics of trip chains are studied using cross tables of connecting structure of purpose in sequential trips. Here, some results on the structures by job are found as in Figures 5, 6 and 7, respectively. In the connecting structure of workers, preceding trip for commuting is the starting trip of connecting flow. The following trips are generally trip attraction for commuting trip, trip generation for business trip, trip attraction for business trip, trip generation for private trip, trip attraction for private trip and trip generation for other private trip (back), in that order. We can obtain the connecting flow diagrams of trips for all of groups by personal attributes.
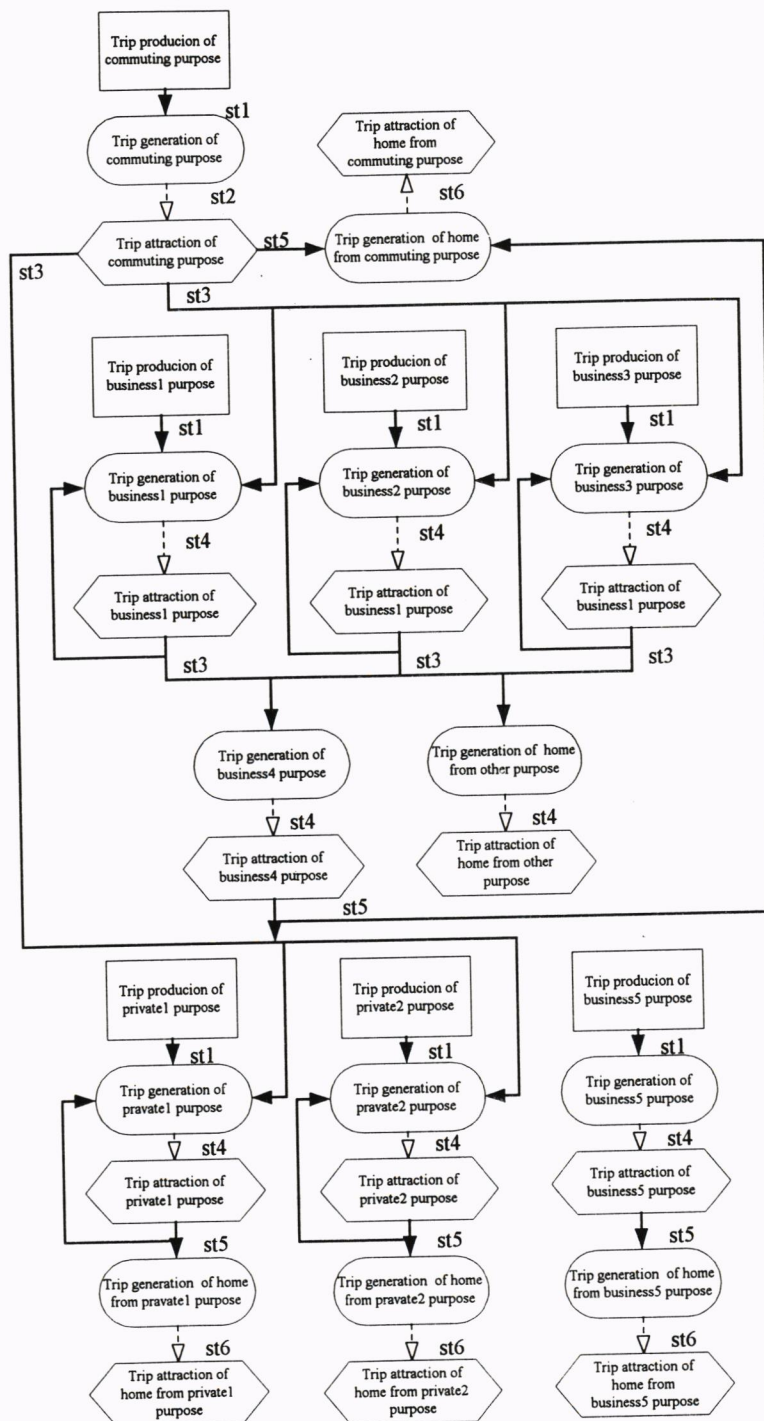
Study on the Structural Mechanism of Traffic Demand Based on the Connecting Structure of Trip Purpose

Note: ──▶ Connecting frow based on the consideraion of sequential trips.
---▷ Trip attaraction related to the trip generation.

Figure-5 Sequential connecting structure of trips for workers

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA
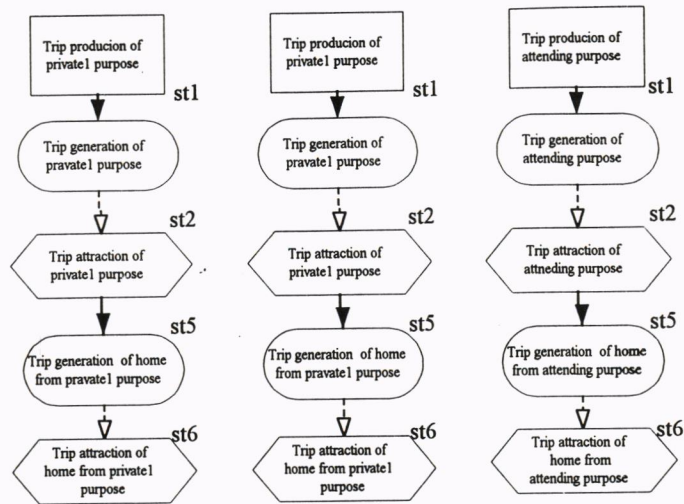
Figure-6 Sequential structure of trips for wife and unemployed
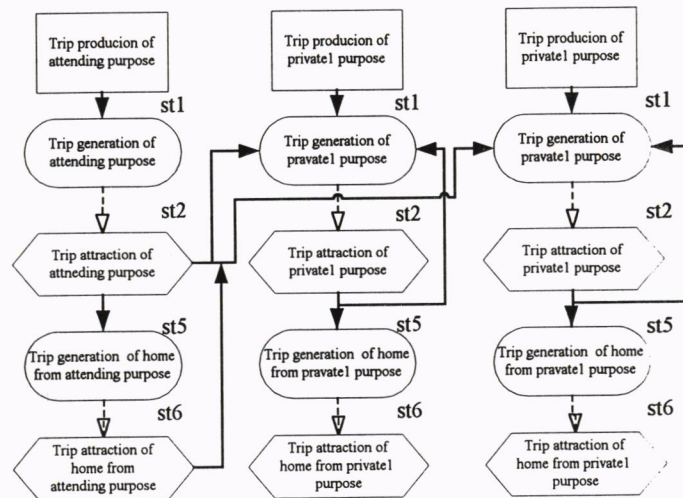
Note: ⟶ Connecting frow based on the consideraion of sequential trips.
⤙⤙⤙▷ Trip attaraction related to the trip generation.

Figure-7 Sequential structure of trips for student and child

5. MODELS OF TRIP GENERATION & ATTRACTION UNDER THE CONSIDERATION OF CONNECTING STRUCTURE OF SEQUENTIAL TRIPS

5.1 Concept of modeling

Trip generation & attraction models by every trip purpose are usually constructed using explanatory variables concerning with zonal characteristics, not thoroughly including personal attributes. As mentioned at previous chapters, it is evident that travel activities are different between personal attributes. So, models in every step at traffic demand must be

built up by groups of personal attributes, keeping temporal and spatial transferability and reappearance of models.

Sequential mechanism of trips is different among personal attributes. However, it can be said that following six steps model is generally proposed on the basis of connecting mechanism in traffic activities.

Step 1. Ratios of trip generation in trip production are studied in each group. If ratios in all zones are almost constant in a group, it is appropriate to use the value as a model. If not constant value, it is necessary to build up a model by multiple regression analysis using explanatory variables concerning with zonal characteristics.

Step 2. Models for ratios of trip attraction in trip generation are constructed using trip generation in step 1.

Step 3. Ratios of intermediate trip generation in the sum of trip production and trip attraction for mainly preceding purposes are modeled. In the same way of step 1, if the values of ratios are constant though all of zones, it is not necessary to construct the model.

Step 4. Models for ratios of trip attraction in trip generation in step 3 are constructed.

Step 5. Ratios of trip generation for home purpose in trip attraction for preceding purpose are considered. In the same way of step 3, if the values of ratios are constant though all of zones, it is not necessary to construct the model.

Step 6. Models for ratios of trip attraction for a home purpose in trip generation in step 5 are constructed.

5.2 Model of trip generation

According to steps for construction of model as above mentioned, models of trip generation are constructed by the following new concept. Using cross tables of trip connections in each group of individuals, preceding trip attraction, which is related with a subjective trip generation, is obtained. And, the following equation can be applied.

$$y_j = \frac{g_j}{x_j}$$

Where y_j : ratio of trip generation trip attraction in zone j;
g_j : number of trip generation for a purpose in zone j;
and x_j : number of preceding trip attraction with some purpose connected with the following trip generation.

In each case of purposes such as commuting, attending to school, back from school and other private (back), this equation is applicable.

In the case of other purposes, the following equation is assumed.

$$y_j = \frac{g_j}{x_{j0} + a_1 x_{j1} + a_2 x_{j2} + \cdots + a_n x_{jn}}$$

where y_j : ratio of trip generation by trip attraction in zone j;
g_j : number of trip generation for a purpose in zone j;

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

x_{j0} : number of trip production with same purpose as the one of subjective trip generation in zone j;

x_{ji} : number of trip attraction for some purpose which the subjective trip generation in zone j;

and a_i : ratio of .trip generation by preceding trip attraction with purpose i.
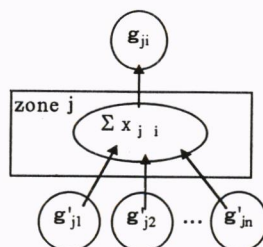
where g'_{ji} : number of preceding trip attraction with purpose i in zone j;

g_{ji} : number of trip generation for purpose i in zone

and

$\sum_i x_{ji}$:all of preceding trip attraction in zone j.

$$a'_{ji} = \frac{g_{ji}}{\sum x_{ji}}$$

$$a_i = \frac{1}{m}\sum_j a'_{ji} \quad \text{(m: number of zone)}$$

Figure-8 Explanation of coefficient, a_i

Here, the explanation of coefficient, a_i, is shown as in Figure-8. If y_j of all zones can be seemed to be a constant value in the purpose. Average of y_j of all zones is adopt for the model of trip generation. If it is not constant, models must be constructed by multiple regression analysis using zonal indices. To determine whether it is adopted, the use of the coefficient of variation (σ/μ), can be proposed. Here, if the ratio of standard deviation by average of all zones is under 0.10, y_j is regarded as constant value in the group. If not small value of σ/μ, then , the model of y_j will be constructed using zonal indices.

5.3 Model of trip attraction

In the same way of trip generation, using cross tables of trip connection in each group, trip generation for preceding purpose, which is related to trip attraction for a purpose, is selected. It can be proposed that trip attraction models are constructed using the ratio of trip attraction for a purpose by trip generation. However, zones of attracted trips are defferent and they can no handle easily to make the model. Therefore trip attraction is divided into 2 groups to grasp OD characteristics; trips originated from a zone and destined to the same zone, x'_j, and trips originated from a zone and attracted to the zone x''_j. Models are constructed using ratio(κ) of x'_j by trip generation in former and ratios (ρ) of x''_j by trip attraction in latter.

$$\kappa_j = \frac{x'_j}{g_j} \qquad \rho_j = \frac{x''_j}{x_j} \qquad (1)$$

where x_j : number of trip production in with a purpose in zone j;

and g_j : number of trip generation with a purpose in zone j.
Equation for trip attraction obtained from these 2 models.

That is,

$$x_j = x'_j + x''_j$$

Substitution Eqs.(1) into the equation,

$$x_j = \kappa_j g_j + \rho_j x_j$$

So, we obtain the equation for trip attraction as follows:

$$x_j = \frac{\kappa_j}{1 - \rho_j} g_j \qquad (2)$$

In this model it can be said that characteristics of OD and the zone are taken into consideration, because trip attraction is divided into 2 groups; the trip generated from the zone and attracted to its zone, and trip generated from other zone and attracted to the zone.

6.   APPLICATION AND REAPPEARANCE OF MODELS

Here, due to limitation of space of this paper, as for group 1 of clerical and related workers of male, the models for trip generation and trip attraction are applied and checked in their reappearance.

6. 1 Trip generation model

For example, the models for commuting trip and business 2 trip in group 1, for clerical and related workers (male) are found as in Table-9. The ratio of commuting trip by trip production is regarded as constant value(1.031).

Table-9 models of commuting and business1 by group1 in clerical and related workers (male)

Purpose1 Commuting		
X_0 = trip production		
Average		1.031
Dispersion		0.00053
Standard deviation /Average		0.022
Correlation coefficient		0.9997
Purpose4 Business2		
X_0 = trip production		
X_1 = trip attraction of commuting	a_1 =	0.0915
X_2 = trip attraction of business1	a_2 =	0.0918
Average		1.810
Dispersion		0.249
Standard deviation /Average		0.276
Correlation coefficient		0.995

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

On the other hand, the models for business2 trips by group 1 in clerical and related workers (male) is shown as in Table-10. Valuables if No.1 and 12 are used as explanatory variables in this model. These are composition ratio of trip generation for a purpose and trip attraction for some purpose which the subjective trip generation by trip generation for commuting trip without separation by individual attributes. Correlation coefficient is low, but, F-value is high.

Table-10 Model of trip generation as to business2 of group1
in clerical and related workers (male)

Business2	Variables	Parameter	F- value
Explanatory variables	1	-11.331	9.731
	12	-47.825	3.51
Constant			4.092
F-value			5.29
Correlation coefficient			0.553

Note: Variable No. follows as in Table-2

Using the above model, relationships between observed trips and predicted trips for business2 is shown as in Table-11, Figure-9 also shows the total trip generation each zone for group1 at clerical and related workers (male). It can be found that the estimated trip generation is corresponds with the observed one.

Table-11 Reappearance of trip generation as to bussiness 2 of group 1
in clerical and related workers (male)

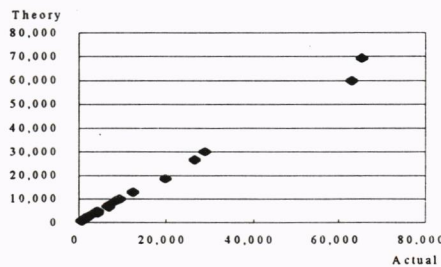|	
Standard error	247.4
Average of actual	2235.2
Rate of standard error	11.07
RMS error	307.5
Correlation coefficient	0.998

Figure-9 Relationships between observed trips and predicted trips of trip generation
for all purposes in group 1 of clerical and related workers (male)

6.2　Trip attraction model

As mentioned above, trip attraction is forecasted by the use of κ and ρ models after finding trip generation. Explanatory variables composition ratios in zone of trip attraction for all purposes by trip purpose. For example, the result of model of trip attraction for

commuting in group 1 of male is shown as in Table-12.
The result of relationships between observed values and estimated values are shown as in Table-13 and Figure-10. The precessions of models are no problem.

**Tabel-12   Model of trip attraction as to commuting of group 1
in clerical and related workers (male)**

κ model	Variable	Parameter	F-value
Explanatory variables	1	1.828	51.419
	7	1.480	7.672
Constant			0.0320
F-value			25.710
Correlation coefficient			0.827

ρ model	Variable	Parameter	F-value
Explanatory variables	7	-4.774	73.195
	15	-4.172	23.649
Constant			0.967
F-value			55.489
Correlation coefficient			0.907

Note: Variable No. follows as in Table-2

**Table-13 Reappearance of trip attraction as to commuting of group1
in clerical and related workers (male)**

Standard error	3384.8
Average of actual	6656.2
Rate of standard error	50.9
RMS error	26783.5
Correlation coefficient	0.967
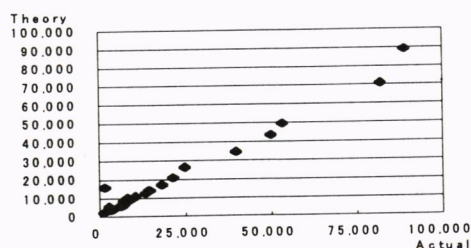
**Figure-10 Relationships between observed values and estimated values of
trip attraction for all purposes by group1 (male)**

7. CONCLUSION

In this study, travel characteristics are examined using the concept of trip connecting mechanism in each group of personal attributes, and forecasting models of trip generation & attraction are constructed. Obtained models are based on four steps model which is usually used in the making of master plan for traffic and so on, but, travel characteristics

Tomonori KOUHARA, Takeshi CHISHAKI and Yoshitaka KAJITA

are studied in detail based on differences of traffic activities among personal attributes. If sequential relationship between former and latter trips by person attributes is analyzed, trip generation & attraction is generally obtained by grasping basic trip production

Here, only forecasting models of trip generation & attraction are built up and forecasting system of these models studied. Needless to say, forecasting model and system of trip distribution will be also studied based on the different pattern of traffic activities among personal attributes. Moreover, choice sets are different among personal attributes in modal choice, so we should find the suitable models for model choice in each group of individual attributes.

REFERENCES

Nakashima, H., Chishaki, T. and Kawano, M.(1987) Categorization of Traffic Purpose in Travel Demand Analysis. **Technology Reports of Kyushu University**, Japan,Vol.60, No. 6, 695-703,December 1987.

Kajita, Y., Chishaki, T., Nakamura, H.and Fuchinoue, H. (1998) Impact of the change of social situation on traffic demand in regional hub city in Japan. **Proceedings of the 1st Asia Pacific Conference on Transportation and the Enveronment**, 1998.

Kajita,T., Chishaki, T., Shih, W. and Tatsumi, H. (1996) Modelling of modal choice using the user's consciousness. **Technology Reports of Kyushu University**, Japan, Vol.69, No. 6, 763-770, September 1996.